

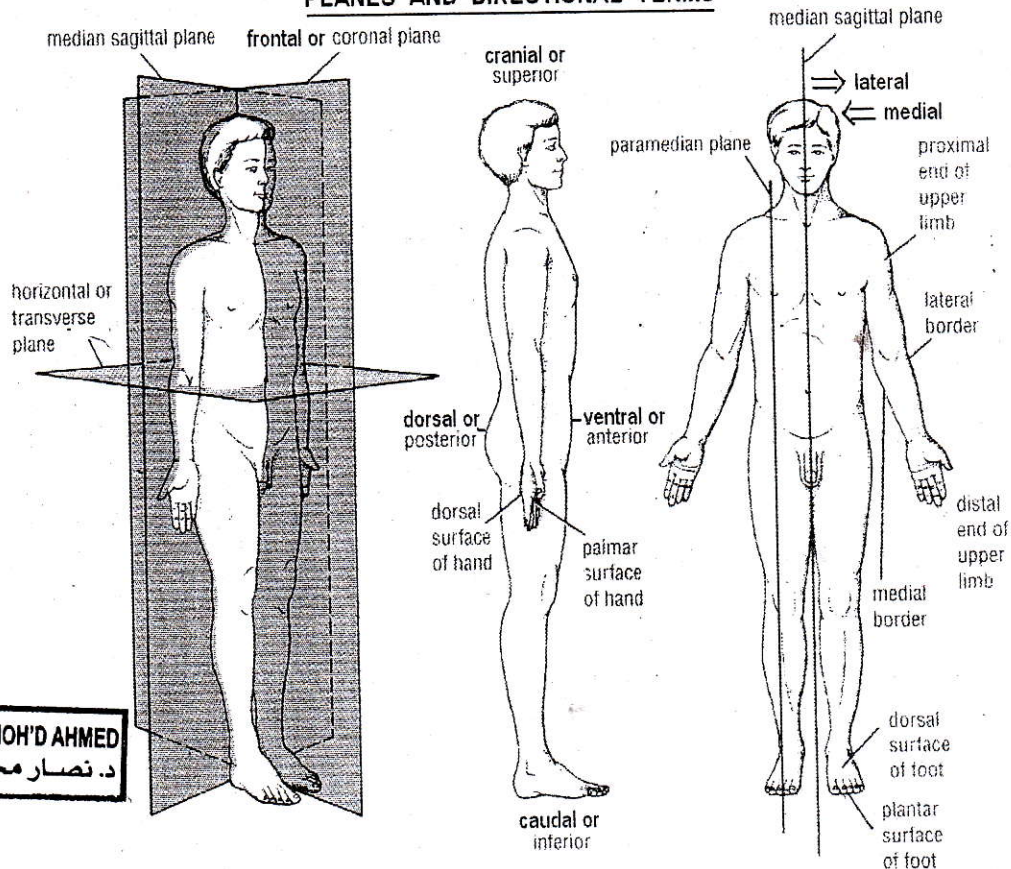
فارس العنبر

UNIVERSITY OF ADEN. FACULTY OF MEDICINE AND HEALTH SCIENCES
DEPARTMENT OF MORPHOLOGICAL SCIENCES
HUMAN ANATOMY I FOR MEDICAL STUDENTS

(Lecture # 1&2)

Dr. NASSAR MOH'D AHMED
د. نصار محمد أحمد

PLANES AND DIRECTIONAL TERMS



Dr. NASSAR MOH'D AHMED
د. نصار محمد أحمد

WELCOME TO ANATOMY

GENERALITIES OF ANATOMY

GENERAL OSTEOLOGY & ARTHROLOGY

sternum
مخاريط
single

INTRODUCION TO HUMAN ANATOMY

Definition

Human anatomy is the science that studies the structure (form, construction, location) of the human body and its parts, systems and organs, as well as the relationship between the structure and function of them.

The word 'anatomy' was introduced first by the great Aristotle about 2300 years ago. It is derived from the Greek roots 'ana': up, 'tome': cutting; the ancient and present method to search and discover the morphological characteristics of the body structures.

Although the study of dead bodies is indispensable in Anatomy at any time, nowadays, its actual aim is the proper comprehension of the relationships between structure and function in the living body.

It is very difficult, almost impossible to understand the origin, development, signs, symptoms, and possible consequences of the diseases and also you will hardly be able to reach a proper diagnosis and prognosis for a patient without a proper knowledge of the Anatomy of the human body. Thus, in the present time it is very necessary to learn Human Anatomy with a functional and clinical approach, anatomy for applying in the medical practice.

Relation to other sciences

Human Anatomy -in the past- was a mere descriptive science, primary concerned with the identification, naming and description of the body structures visible to the naked eye, what we call now "Gross (macroscopic) Anatomy".

Modern anatomy deals with the structure of the human body ranging from the gross (macroscopic) to sub-cellular (molecular) levels, as well as with the ways in which development and growth make or alter the structure (and consequently the function).

Many medical and paramedical fields need the basic information provided by anatomy to perform their work properly; surgery, internal medicine, legal (forensic) medicine, anthropology, etc.

The introduction of advanced diagnostic technologies and means such as: CAT, MRI, images reconstruction requires a deep anatomic knowledge to interpret the images. Conversely, Anatomy has enriched itself by the fast development of these applied sciences.

Although Anatomy is one of the branches of the so called 'morphological sciences' within of biological sciences, is strongly related with the social sciences.

WAYS AND METHODS OF STUDY



Performing of Anatomy studies can be approached by two ways; cadaveric anatomy and living anatomy.

In cadaveric anatomy, the structures of the body are studied by dissection (It. 'dis'=asunder, 'scare'=to cut up) to the naked eye or at least with the aid of magnifying lenses, on the cadaver (corps/dead bodies), or on isolated organs (viscera, joints, etc).

In living anatomy, the search is carried out on the living subject (individual/patient) by a number of methods, ways or technological means to examine the body:

- Inspection: visual examination of posture, walking, surface contours, shape, proportions, color, etc.
- Palpation: touching of the body gives information about position, size, shape, consistence, mobility of the structures, also arterial pulse, muscle tone, deformities, outgrowths, etc.
- Percussion: tapping on the skin surface by the fingers produces sounds of different qualities resulting from physical status of the underlying organs or tissues.
- Auscultation: listening of the natural sound produced by a number of viscera during their normal or pathological function or movement (e.g. heart sounds, breathing sounds at lungs and bronchi, fetal sound, etc) usually by the aid of a stethoscope.

Surface anatomy descriptions provide important and indispensable information to perform the above mentioned four methods successfully.

= Endoscopy: examining of deep parts of the body cavities or hollow organs through natural or surgically performed orifices. A special device is used (endoscope).

- Radiography (X-ray films) -plain or contrasting - and other radiological image providing techniques such as Computerized Axial Tomography (CAT scan), Dynamic Spatial Reconstructor (DSR scan), Magnetic Resonance Imaging (MRI), Position Emission Tomography (PET scan), all are used to obtain different kinds of images of internal structures of the living body at some stages of or during their normal or pathologic functions.

The information obtained may be organized into two different ways:

- I) **Systematic Anatomy**: the organs and structures of the body are described as forming groups called **system**. Each system consists of a number of organs (viscera) and structures with similar embryologic origin, made up by



similar tissues, and concerned with specific functions. Some systems are described together, due to a number of structural and/or functional similarities, as well as common embryologic origin, common pathologic affections, etc.

- Locomotor system includes skeleton (bones and joints) and muscular system.
- Urinary system and reproductive system form the uro-genital system.
- Lymphatic system and cardiovascular system both constitute the circulatory system.
- Regulation of body activities needs of both the nervous and endocrine systems, which have close relations between them.
- Integumentary, renal (urinary), and respiratory systems, all are parts of the known 'excretory system' due to their function of eliminating waste metabolic products.



II) **Topographic (regional) anatomy:** the human body is divided into a number of regions and sub-regions (superficial and deep) which have specific interest use. We study all organs and structures comprised in each region, independently of the system that they belong to, stressing in their spatial relationships among them.

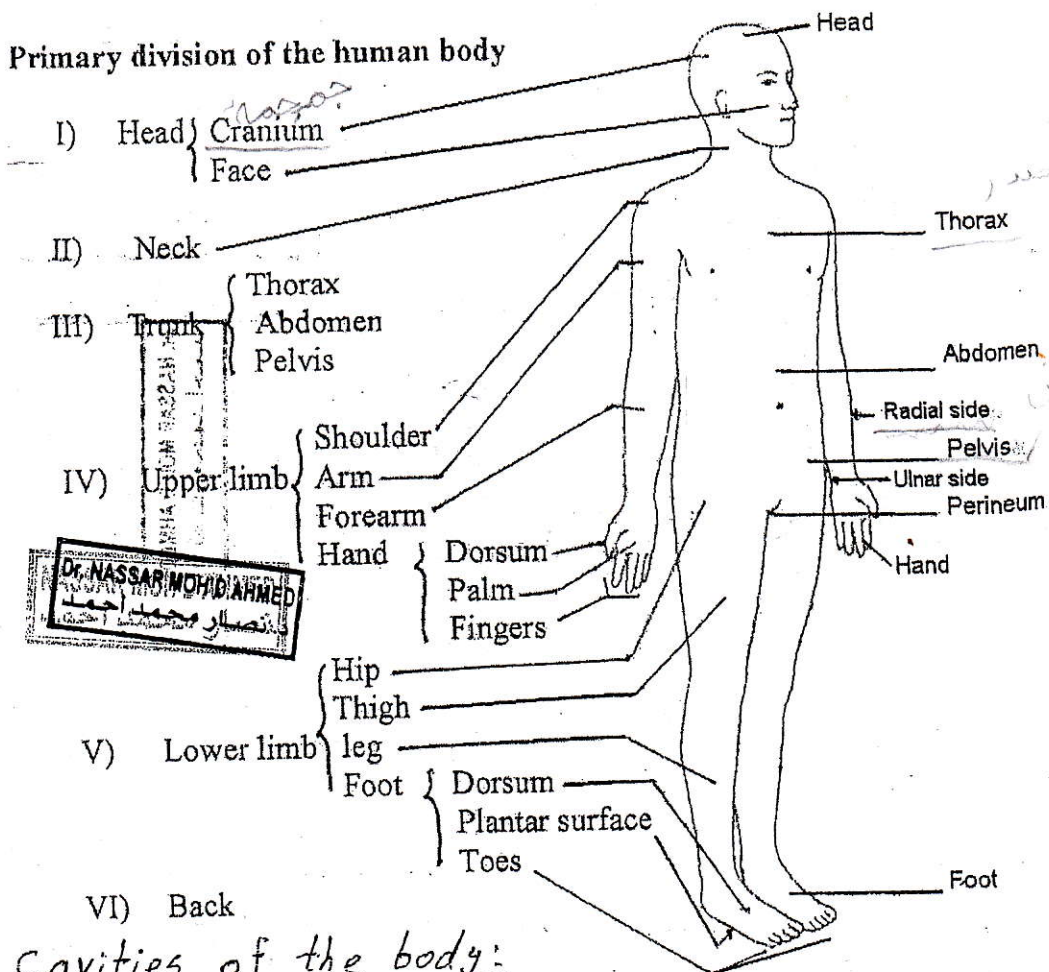
The medical student should know both; systemic and topographic approaches since each one has its own applied use in future practice.

THEN, WHY ANATOMY IS IMPORTANT FOR YOU?

Summarizing: The anatomy is the science about the shapes and the structures of the human body; for it constitutes the **point of outburst** of all medical knowledge. The depth and width of medical sciences is growing incessantly **but the macroscopic knowledge, which is indispensable for a practicing doctor, will not decrease in importance.** You can not learn only half of the muscles, veins or nerves. The importance of some of the information does not lie in the fact that a practicing doctor deals with certain parts of the skull or brain or with the blood supply of the stomach on a daily basis. Rather, they have to make a good physical examination, to understand the diagnoses of other colleagues and the essence of the interventions carried out by specialists and their consequences. **And Anatomy is basic for all these purposes.** The current

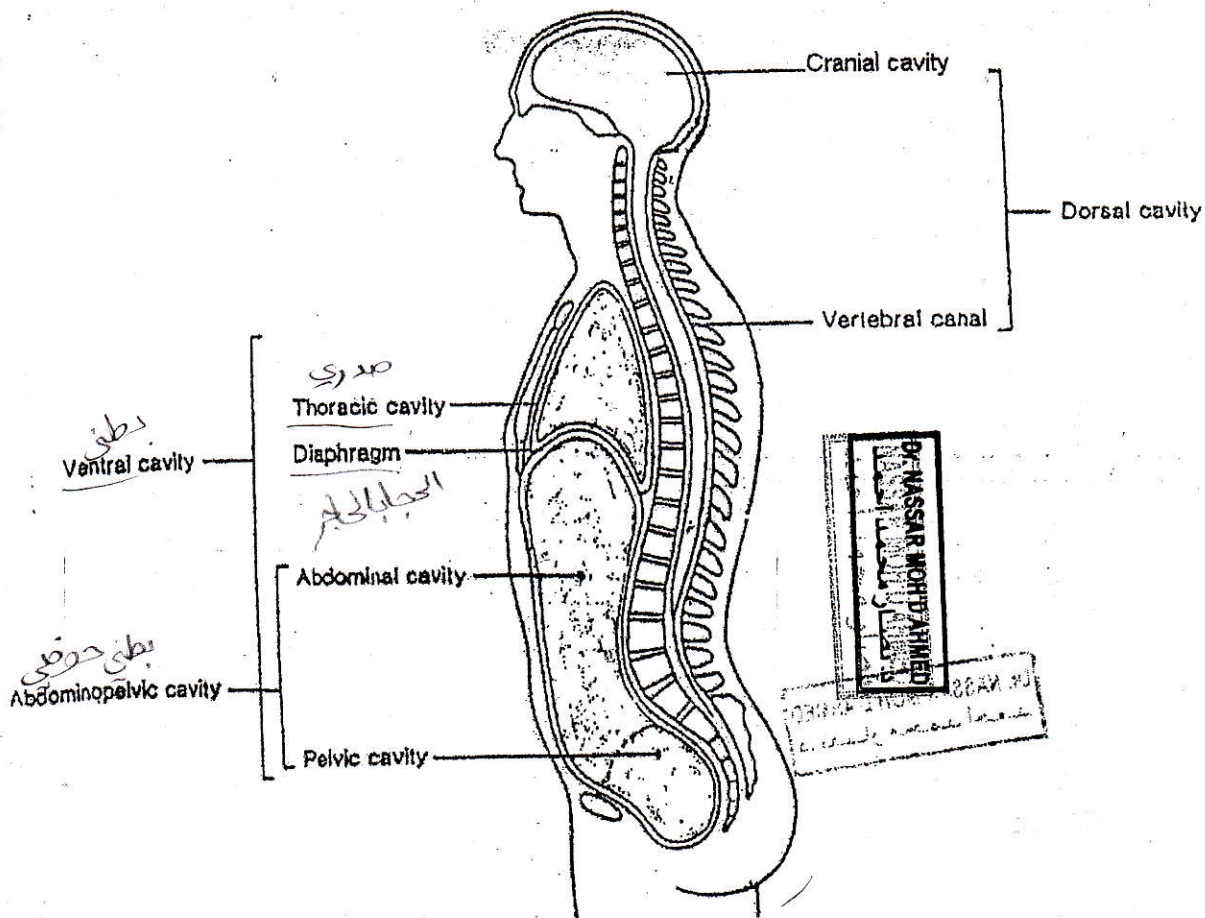
information supplied by the dynamically developing disciplines may become outdated tomorrow, but the majority of the anatomic knowledge - which have been known for hundreds of years - is still valid today and without it, it would be impossible to carry out the simplest medical intervention.

Primary division of the human body



Cavities of the body:

- I. Dorsal cavity**
 - *Cranial cavity → lodges brain
 - *Vertebral canal → lodges spinal cord
- II. Ventral cavity**
 - *Thoracic cavity → lodges
 - Lungs
 - Mediastinum (heart, etc)
 - *Abdomino-pelvic cavity
 - Abdominal cavity (proper) → lodges digestive viscera, kidneys...
 - Pelvic cavity → lodges urinary and genital organs...



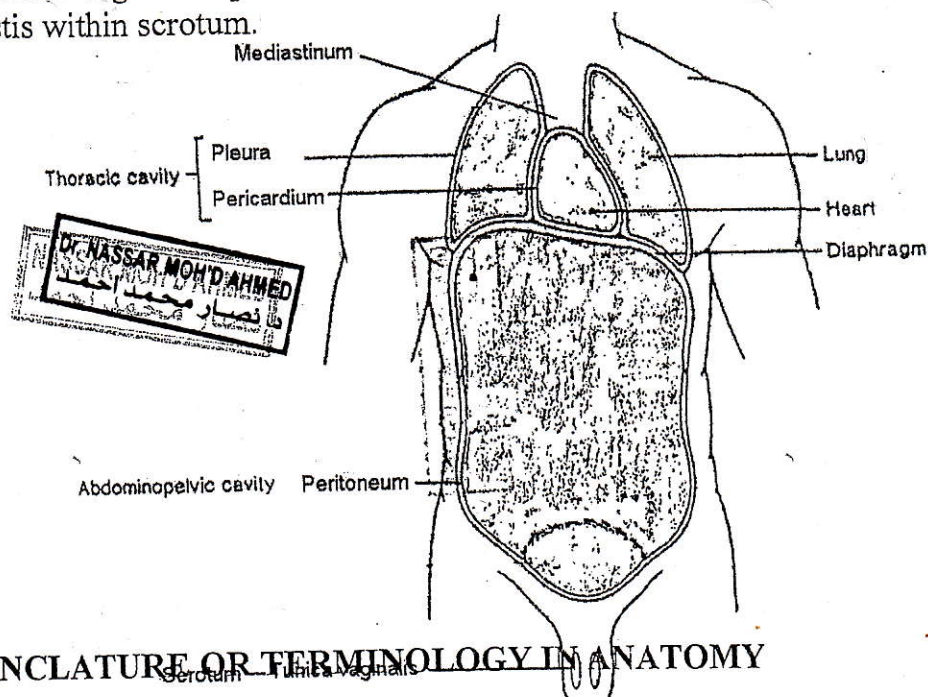
Membranes of the body

1. **Skin** (Integumentary system) including its appendages (hair nails). It is the external covering of the body provided by a keratinized stratified squamous epithelium and an underlying connective tissue.
2. **Mucous membranes**: the moist lining of the alimentary canal, respiratory passages and genital ducts that communicate to the exterior at oral cavity, nasal cavity and anus
3. **Endothelium**: smooth, internal linings of the heart chambers and vessels of the circulatory system.

4. **Meninges:** set of three membranes (pia mater, arachnoid, and dura mater) that covers and protects the organs of the central nervous system (brain and spinal cord).

5. **Serous membranes:** special membranes formed by two layers of connective tissue covered by mesothelium. The visceral layer covers the viscera and the parietal layer lines the internal surface of the cavity containing the viscera. A potential space is between both layers filled up by a serous fluid. There are four main serous membranes:

- **Pleurae:** two serous sacs related to lungs, thoracic cavity and mediastinum.
- **Pericardium:** a fibro-serous sac related to the heart and mediastinum.
- **Peritoneum:** the more extensive serous membrane related to abdomino-pelvic cavity and included viscera.
- **Tunica vaginalis:** peritoneum-derived membrane covering the testis within scrotum.



NOMENCLATURE OR TERMINOLOGY IN ANATOMY

Since Anatomy is mainly a descriptive science, it has accumulated a huge amount of terms (more than 50 000) that have been simplified and standardized up to update 4500 terms approximately. They are included in the **International Nomina Anatomica**. It comprises descriptive terms of the body structures as well as directional terms or terms of orientation to describe the position of the structures.

All descriptions in Anatomy must be referred to the '**anatomical position**'.

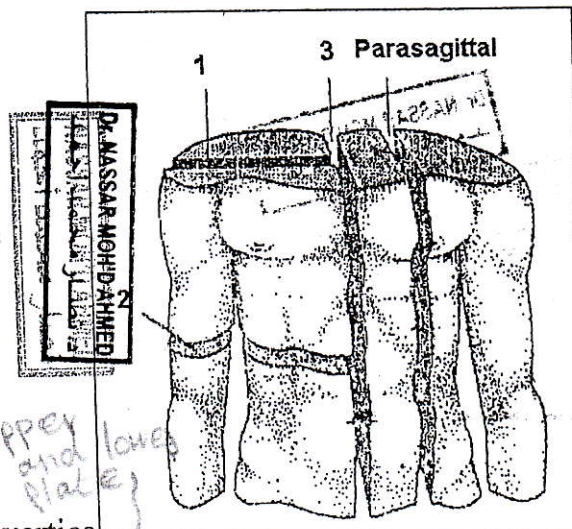
A) **Anatomical position:** It is the standardized position of the human body to which we must refer all anatomical descriptions. It is defined or characterized as:

- The individual is standing up erect in front of the describer. The whole body is directed forwards.
- The lower border of the mandible must be parallel to the floor.
- The upper limbs must be placed by the sides. Palms of the hands facing forwards and thumbs adducted (separated).
- The lower limbs must be placed together, heels in contact to each other, toes pointed forwards and sole of feet flat on the floor.

When the circumstances drive us to describe referring to other position than the anatomical one, we must specify that reference, e.g. 'in supine patients', etc.

B) PLANES OF SECTION

1. Frontal or coronal: dividing the body into anterior and posterior portions. It is vertical and perpendicular to the sagittal plane and horizontal plane.
2. Horizontal or transverse: parallel to the floor, dividing the
3. Midsagittal or median: vertical horizontal and frontal planes, dividing the body into two lateral halves (right and left).
 - Parasagittal or paramedian: any plane parallel to the Midsagittal plane.



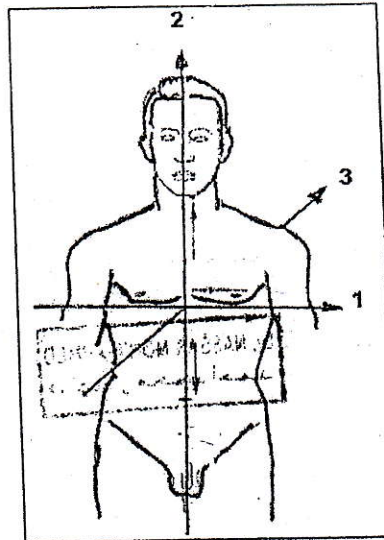
equal planes

unequal planes

C) PRINCIPAL AXES

They are imaginary lines formed by the crossing intersection between two planes, which are perpendicular to each other. They are mostly used to describe the movements of the joints.

1. Transverse: intersection between frontal and horizontal planes.
2. Vertical: intersection between sagittal and frontal planes. Each limbs and appendicular organs have their own principal vertical axis.



D) DIRECTIONAL TERM

They are arranged in pairs of opposite terms describing location of the structures.

Cranial or superior: towards the crown of the head.

Caudal or inferior: towards the sole of feet.

Dorsal or posterior: towards the back, backwards.

Ventral or anterior: towards the front, forwards.

Median: at the midline.

Medial: towards or closer to the midline.

Lateral: away from the midline.

Ipsilateral: on the same side of the body.

Contralateral: on the opposite side of the body

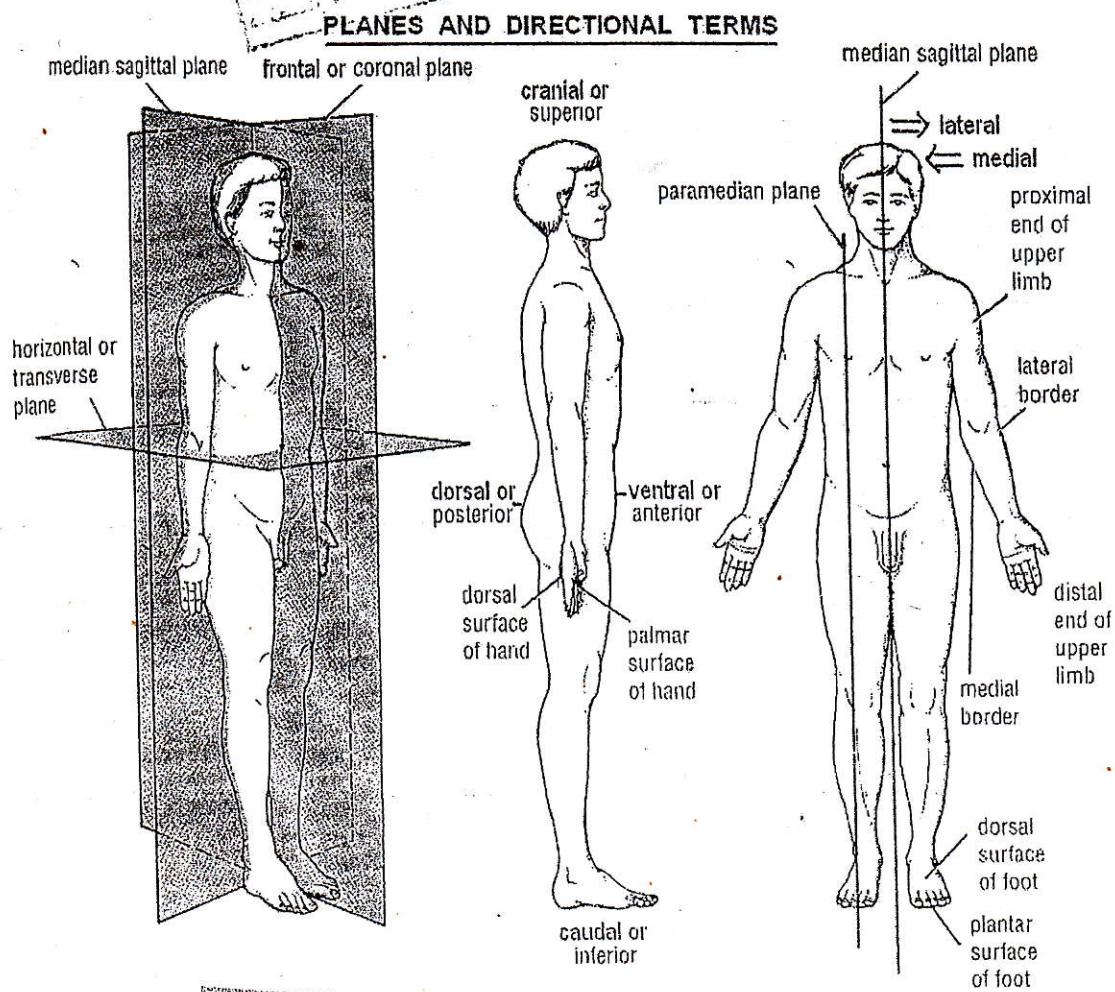
In limbs:

Proximal: towards the trunk.

Distal: away from the trunk.

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د. نصار محمد أحمد

Hand	Foot
<u>Palmar</u> : towards the palm	<u>Plantar</u> : towards the sole
<u>Dorsal</u> : towards the dorsum	<u>Dorsal</u> : towards the dorsum



Taking into account a transverse section:

Away from the vertical axis:

Superficial or external: is referred towards the body surface.

Parietal: related to body walls.

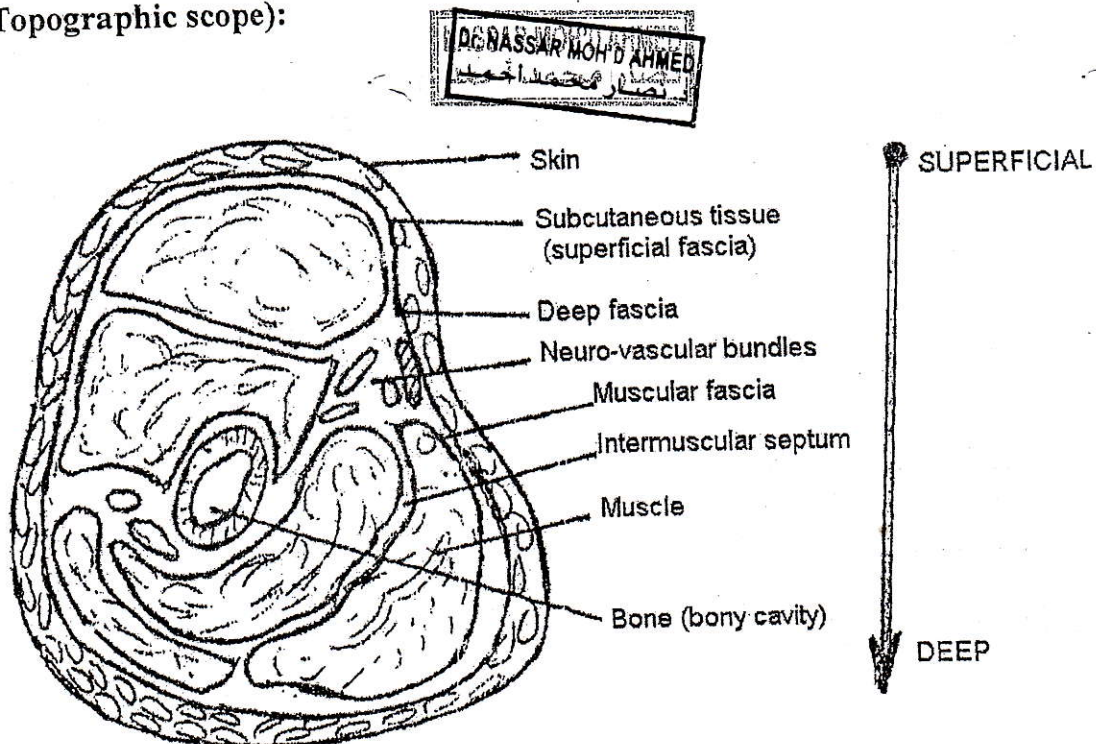
Cutaneous: refers to the proximity of skin.

Towards the vertical axis:

Deep or internal: away the body surface, towards the interior of the body and its cavities.

Visceral: related to internal organs.

General arrangement of the structures from superficial to deep (Topographic scope):



LOCOMOTOR SYSTEM

The Locomotor system is defined as the group of organs responsible of the mechanical functions of the body. It comprises:

A) Passive part → Skeleton { Bones
Joints

B) Active part → Muscles (and related structures)

الوظائف
التي تؤديها
العضلات
والهيكل العظمي
السلبي

Functions:



Mechanical

- Movements of the body in the space. Walking.
- Movements of parts of body.
- Maintenance of posture and balance.
- Protection of internal organs and bone marrow.
- Framework for the body support of soft tissues.
- Growth

Metabolic

- Storage of mineral salts (calcium, phosphorus).
- Production of blood cells (by the bone marrow).
- Rapid ion exchange.
- Production of body heat (by muscles)

The structures of the locomotor system account for about 70%-80% of the total body weight (T.B.W): bones about 20% and muscles about 40%-50%. Its study includes three main sections:

OSTEOLOGY

The study of bones

ARTROLOGY

The study of joints

MYOLOGY

The study of muscles

الجزء السلبي
من النظام
الحركي

OSTEOLOGY

Bones are approximately 206 pieces in the human skeleton, each one is a living organ composed by:

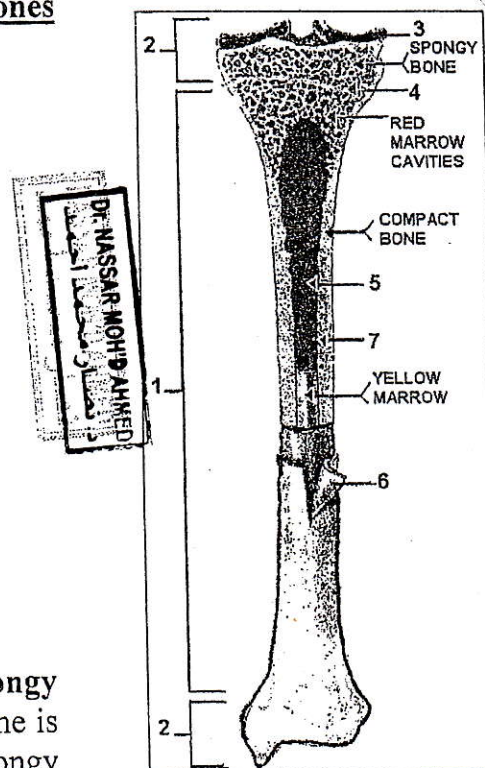
A) Organic framework (about 1/3): cells, connective tissue, blood and lymph vessels, nerves, bone marrow, adipose tissue.	Provides elasticity	RESISTANCE (Strength)
B) Inorganic content (about 2/3): mineral salts, mainly CaPO_4 .	Provides hardness (rigidity)	

Gross (macroscopic) structure of the bones

Typical (long) bone consists of:

1. Diaphysis (shaft or body)
2. Epiphysis (ends or extremities)
3. Articular cartilage (smooth surface for the joints)
4. Epiphyseal plate (growth plate of hyaline cartilage)
5. Medullary cavity (lodging the bone marrow)
6. Periostium (covering external layer of connective tissue)
7. Endostium (lining of medullary cavity and spaces of the spongy bone)

Epiphyses are mainly formed by **spongy** (cancellous) bone. **Compact** (dense) bone is found at the diaphysis and covering spongy bone as 'cortical plates or laminae'.



The main blood supply of the bone and bone marrow enters via nutrient foramina, which have fixed location in each bone (applied feature for orthopedic surgery).

Markings of the bones (bony surface features)

They are produced by the presence or influence of muscles, tendons, ligaments and other soft tissues and organs related to bones, which are called 'functional matrices'. Most of them can be palpated. They are grouped in three main types:

- Elevations: process, eminence, protuberance, tubercle (trochanter, or tuberosity), condyle, ridge, line, spine, head (caput), border (margin), crest, etc.
- Depressions: fossa, fissure (groove or sulcus), notch or incisure, etc.
- Openings: foramen (aperture or orifice), meatus, etc

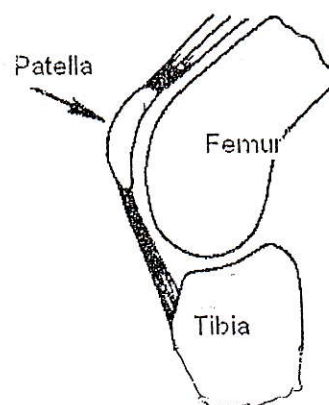
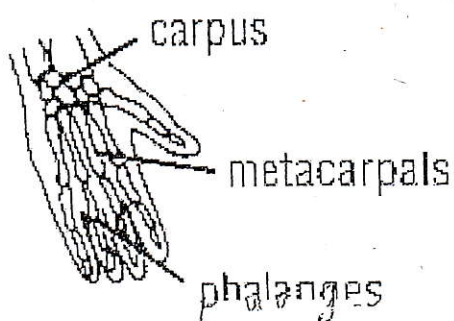
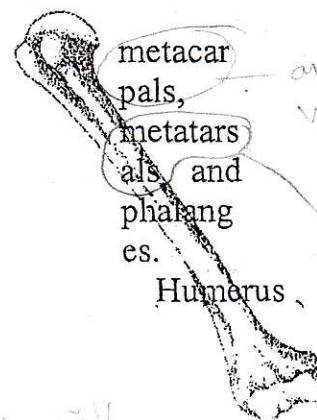
Classification of bones:

We may classify bones from different points of view. Perhaps, the most important is the classification according to shape:

Long bones

- Length is greater than width and thickness.
- They are tubular-shape.
- They show a diaphysis and two epiphyses.
- They are considered as typical bones. Examples: humerus, radius, ulna, femur, tibia, fibula.
- Because the classification is according to shape, not to size, some small long bones are named as 'miniature bones' like

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Short bones

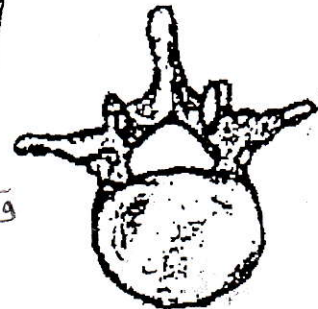
- There is not any predominant dimension.
- They are somewhat cube-shaped.
- Situated in confined spaces where they transfer forces and help movements: carpal and tarsal bones are the typical examples.



Irregular bones

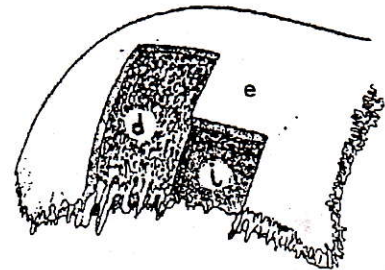
- They show a variety of shape.
- Usually, they combine the features found in other groups of the classification.
- Parts of the same bone derive from different origins.
- Examples: vertebrae, sacrum, coccyx, most of the facial bones, hip bone, occipital bone.

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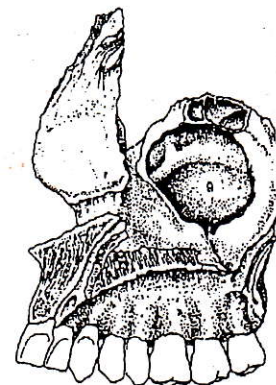
Flat bones

- Here Length and width predominant respect to thickness.
- They consist of two plates (external and internal) of dense bone separated by a single layer of cancellous bone named diploe (d).
- Examples: parietal, nasal, vomer, lacrimal, ribs, sternum, scapula. Most of them are broad plates forming cavities to protect important viscera (cranial and thoracic cavities).



Pneumatic bones

- They are irregular hollow bones containing air-filled cavities within them (air chambers, sinuses): maxilla, frontal, sphenoid, ethmoid and temporal bones.



Sesamoid bones

- Some short bones develop within tendons of muscles. They are called **sesamoid**

bones, like patella

Development of the bones:

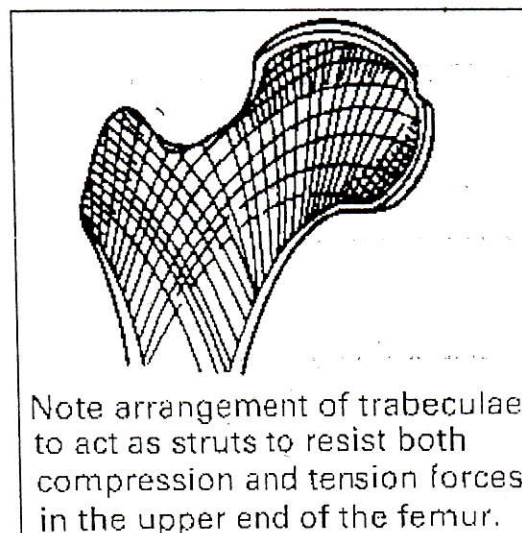
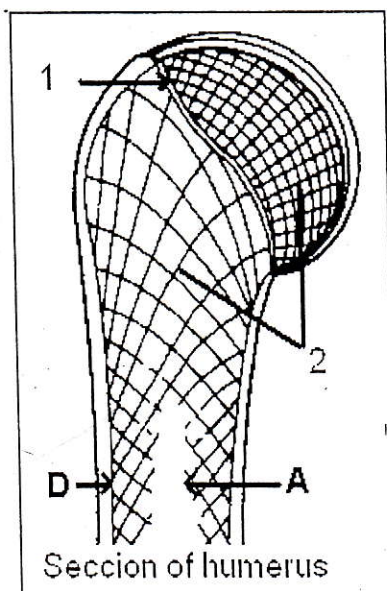
The process of bone formation may take place in relation to an existing cartilaginous structure; this type of ossification is called **endochondral** and occurs in most bones of the skeleton. The second type of ossification is called **intramembranous** because it takes place in an existing layer of dense connective tissue (without cartilaginous stage) as occurs in several bones of the skull or parts of occipital and temporal bones, etc). The process of ossification starts in a region called **center of ossification**, from which it spreads to the rest of the developing bone. Bones may develop from one or more ossification centers.

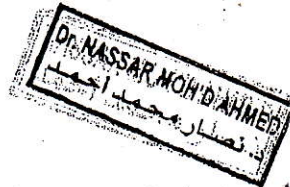
The growth of the bones occurs due to two combined processes:

- **Deposition (D):** formation of new bone. And
- **Absorption (A):** destruction, elimination of old bone.

The combined effect of both growth-processes produces **bony remodeling**, which is the way of response to external and internal influences over the bone.

When growth decrease, the epiphysial plates ossify and the line of fusion between diaphysis and epiphysis is called **epiphysial lines (1)**. The **bony trabeculae (2)** of the spongy bone arrange according to the lines of stress transmission along the bone (trajectorial theory).





- movable point in the skeleton
- junction between two ~~or~~ more bones

ARTHROLOGY

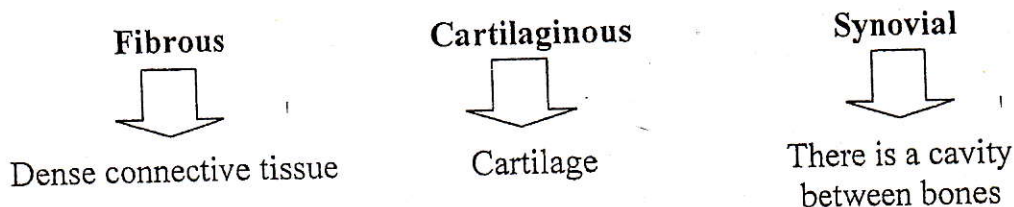
Definition: an articulation or joint is defined as 'a junction between two or more bones'. They are sites of the skeleton possessing less rigidity (hardness) than the rest of the bony framework itself. Hence, their **functions**:

1. **Axes (pivot) of movements:** the bones act as levers of movements so, the movement occurs at the joints.
2. **Cushioning (softening) of blows or forces:** because they include a soft tissue (cartilaginous or connective) or a cavity between the articulating bones, which is less rigid than the bone.
3. **Sites of growth:** At the epiphysial plates of the long bones and at the articular surfaces or borders of the bones.



Prime Classification of joints

The criteria for the classification of joints vary. The most used is based on the kind of tissue interposed between the articular bones:

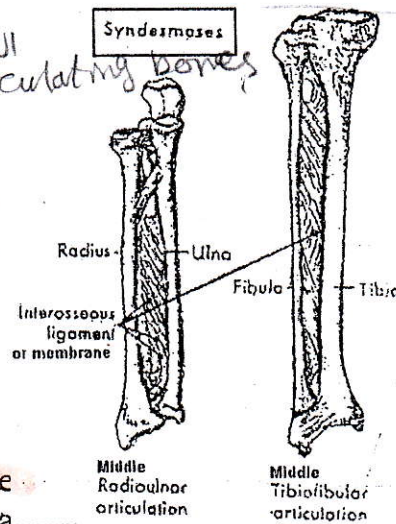


Fibrous and cartilaginous joints are established by continuity of the articulating bones through the intervening tissue. Synovial joints are established by contiguity, because a cavity separates the articulating bones.

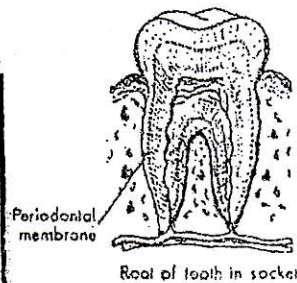
Fibrous joints:

The articulating bones are joined by dense fibrous connective tissue. These joints have almost no movement. The articulating bones develop from intramembranous ossification. They are found in the skull. They are divided into three types:

1. **Syndesmosis:** membranes or ligaments between the articulating bones or parts of them (interosseous). Example middle tibio-fibular. A number of ligaments between vertebral arches and processes.

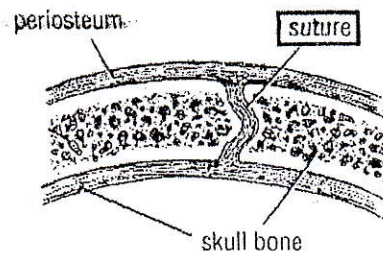


2. **Gomphosis:** it is a special joint established between the roots of the teeth and their corresponding alveolar socket (alveolus) by the **periodontal ligament (PDL)** whose fibers attach to the cementum of the tooth root and to the alveolar bone proper.



3. **Sutures:** They are established between flat-shaped bones of the skull. A thin layer of fibrous connective tissue joins the borders of the articulating bones. According to the shape of the articulating borders, they are divided into:

A. **Serrate:** saw like. They are the most common in the skull. E.g. inter-parietal.



عظمين النحوا

B. Plane: flat, straight junction. They are found mostly between facial bones. E.g. inter-nasal.

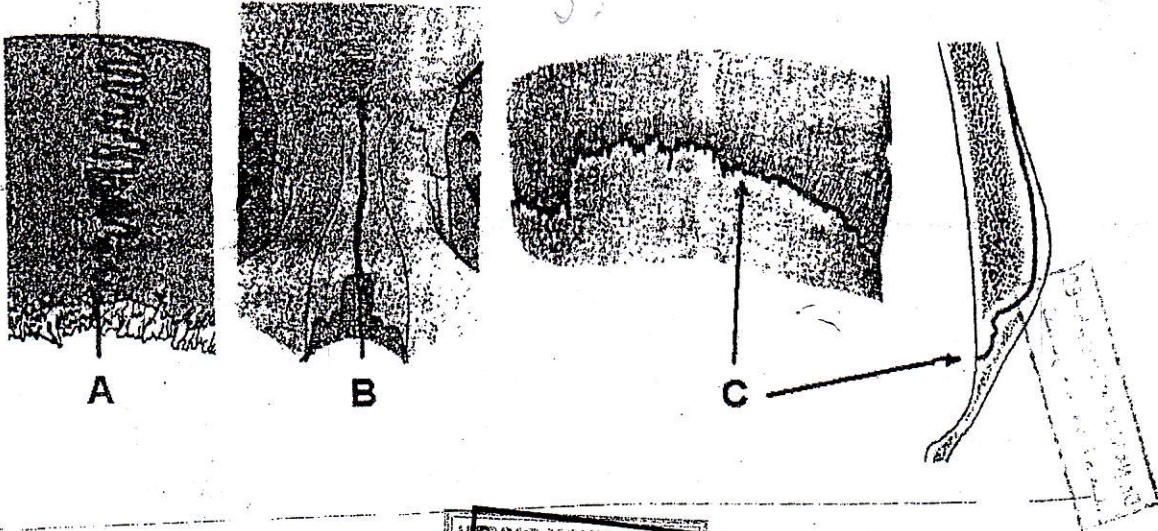
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C. Squamous: bevel edge borders. E.g. temporo-parietal.

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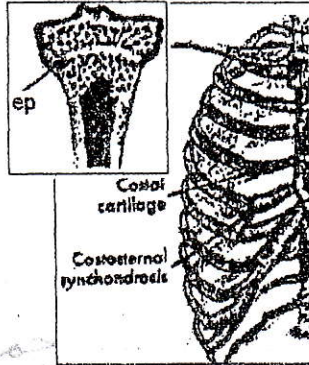


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Cartilaginous joints:

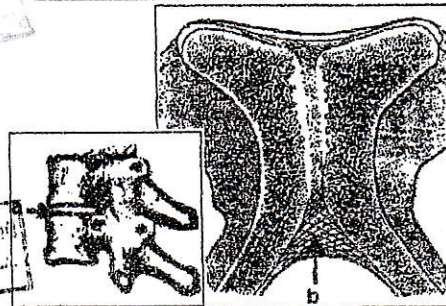
An intervening pad of cartilage joins the bones. These bones usually derive from endochondral ossification. There may be a slight movement at the joint. They are classified according to the type of interposed cartilage:

1. **Symphysis:** they are primary cartilaginous (hyaline cartilage) and temporary joints (ossify or fuse during life). E.g.: between diaphysis and epiphysis of long bones (ep), the first sterno-costal joint, costal cartilages and between bones at the cranial base like spheno-occipital synchondrosis.

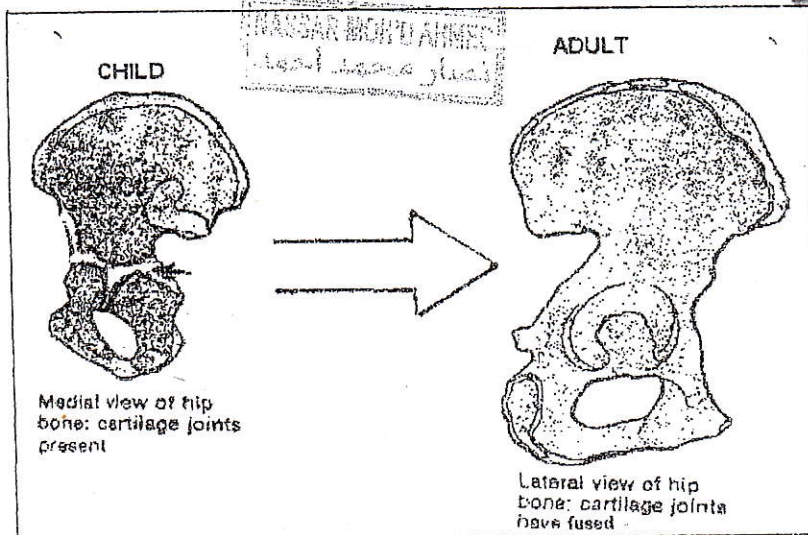


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2. **Symphysis:** they are secondary cartilaginous (fibrocartilage) and most of them are permanent joints. E.g. intervertebral discs (a) and symphysis pubis (b).



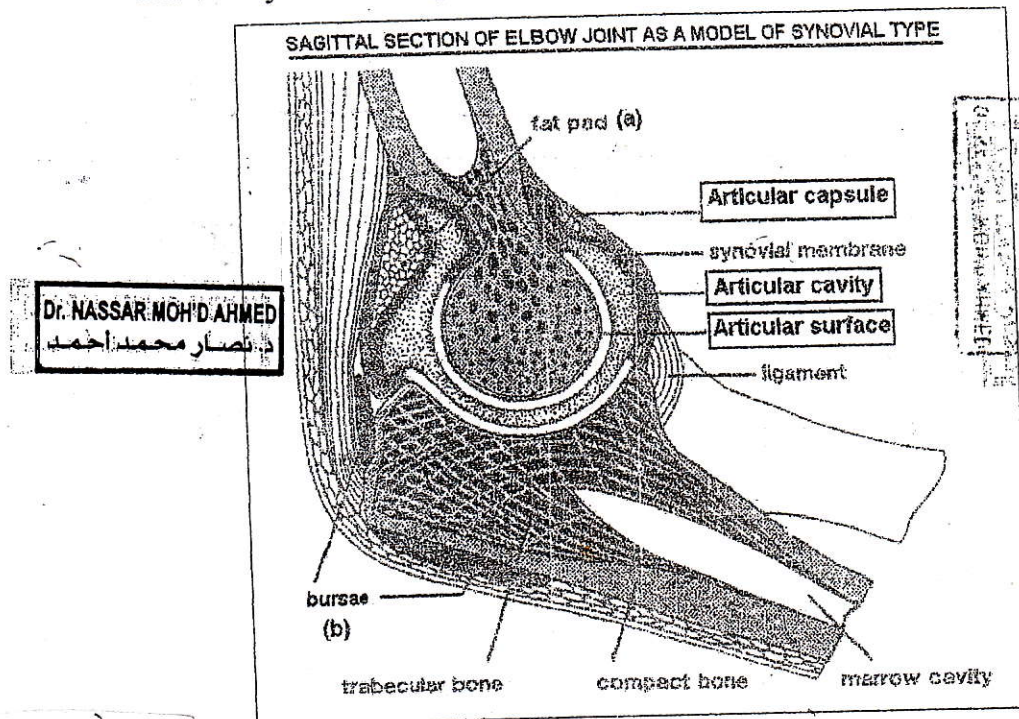
Fibrous and cartilaginous joints are usually replaced by bone during life, becoming synostosis. That is due to cessation of local growth. This is why they are considered 'temporary' joints. E.g.:



Synovial joints:

They are movable joints, characterized by three main features:

1. An articular cavity filled up by Synovial fluid.
2. An articular capsule, formed by two layers;
 - Fibrous (external) layer that thickens forming ligaments.
 - Synovial membrane (inner), which produces the Synovial fluid.
3. Articular surfaces, of the articulating bones which are lined by a thin articular hyaline cartilage.



Accessory structures may be present at the Synovial joints, facilitating movement:

- a) **Fat pads:** pieces of adipose tissue acting as soft cushions.
- b) **Synovial bursae;** extensions of the Synovial membrane interposed between bones and muscles or tendons.
- c) **Sesamoid bones:** a kind of ~~bone~~ bone that develops within a tendon. They provide an additional articular surface that helps or modifies articular movements. E.g.: patella bone in the knee joint.
- d) **Intra-articular fibrous cartilages;** they are pieces of fibro-cartilages interposed between the articular surfaces with the following

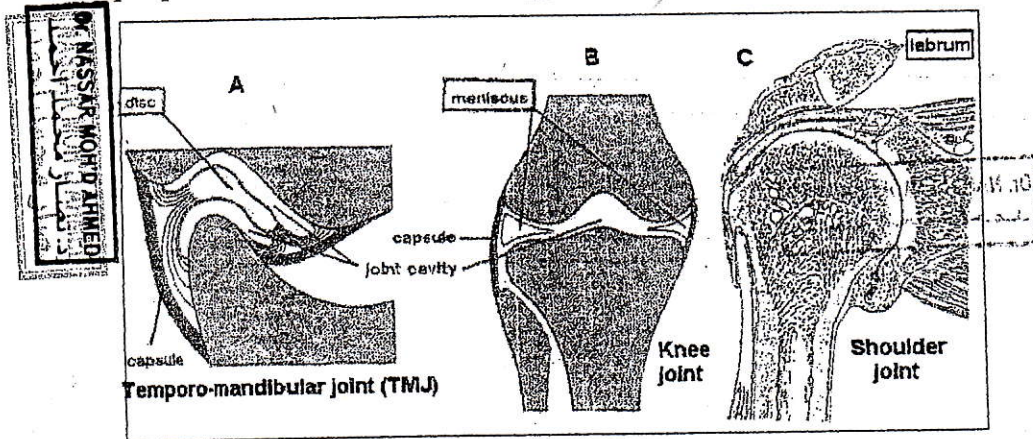
Functions:

- They modify the shape and size of the articular surfaces to fit them properly.

- They increase the number and quality of the movements by providing a new pair of articular surfaces.
- They act as cushions that diminish the effect of blows, pressure, impact, forces, etc.

There are three types of intra-articular cartilages:

- Disc:** a complete plate of fibro-cartilage that divides the articular cavity into two compartments.
- Meniscus:** a crescent-shaped pair of fibro-cartilage plates that deepens a flat surface.
- Labrum:** a concave ring of fibro-cartilage placed around the peripheral border of an articular fossa.



Classification of Synovial joints according to the number of articular surfaces

- Single:** only two (the minimum) articular surfaces. Examples: interphalangeal, metacarpo-phalangeal, metatarso-phalangeal, temporo-mandibular, acromio-clavicular, shoulder joint, hip joint, proximal tibio-fibular, sacro-iliac, sterno-clavicular.
- Compound:** more than two articular surfaces (three or more). Examples: elbow joint, knee joint, radio-carpal, ankle joint, internasal and intercarpal joints.
- Complex:** due to the presence of an intra-articular cartilage. Example: shoulder joint, hip joint, knee joint, radio-carpal joint, sterno-clavicular joint and temporo-mandibular joint.
- Combined:** structurally, they are pairs of independent (separated) joint, but they act as a functional unit (they move together at the same time). Example: between articular process of adjacent vertebrae (zygapophysial joints), temporo-mandibular joint and costo-vertebral joints.

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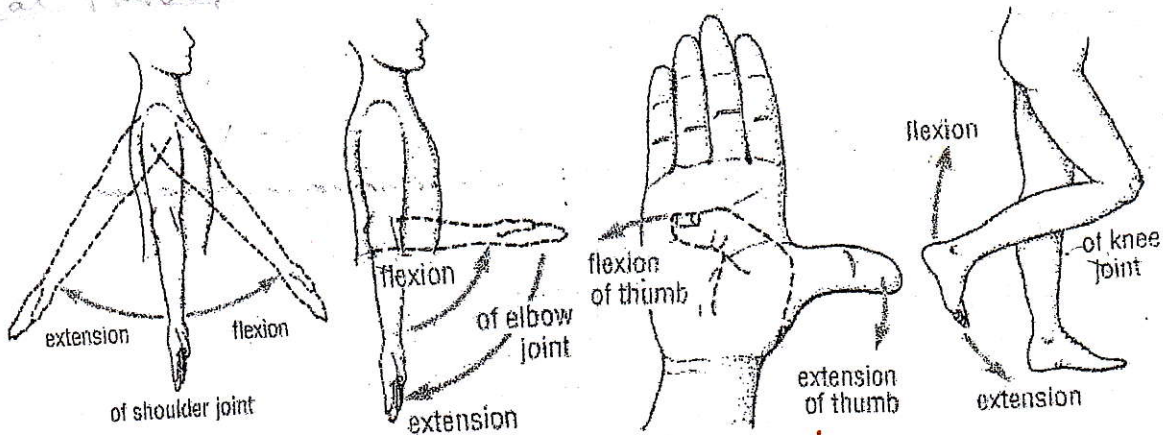
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Movements of the Synovial joints

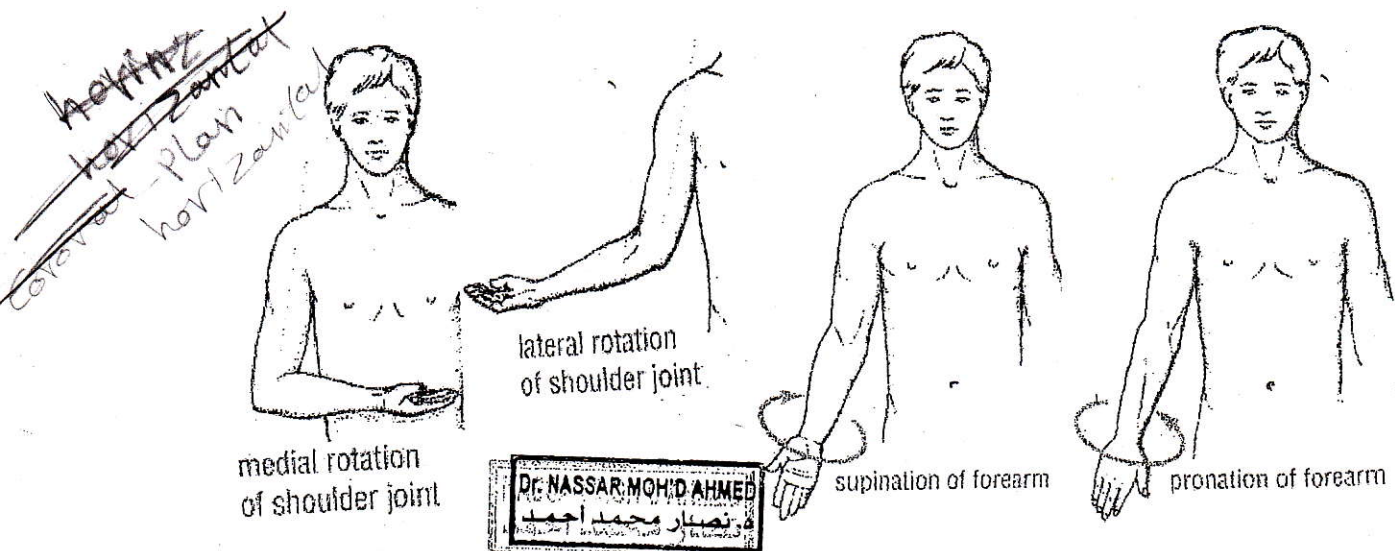
The movements of the Synovial joints are described according to the axis (pivot of movement) around which the movement (a kind of rotation) takes place.

1. Around the transverse ~~or horizontal~~ axis: flexion or extension.

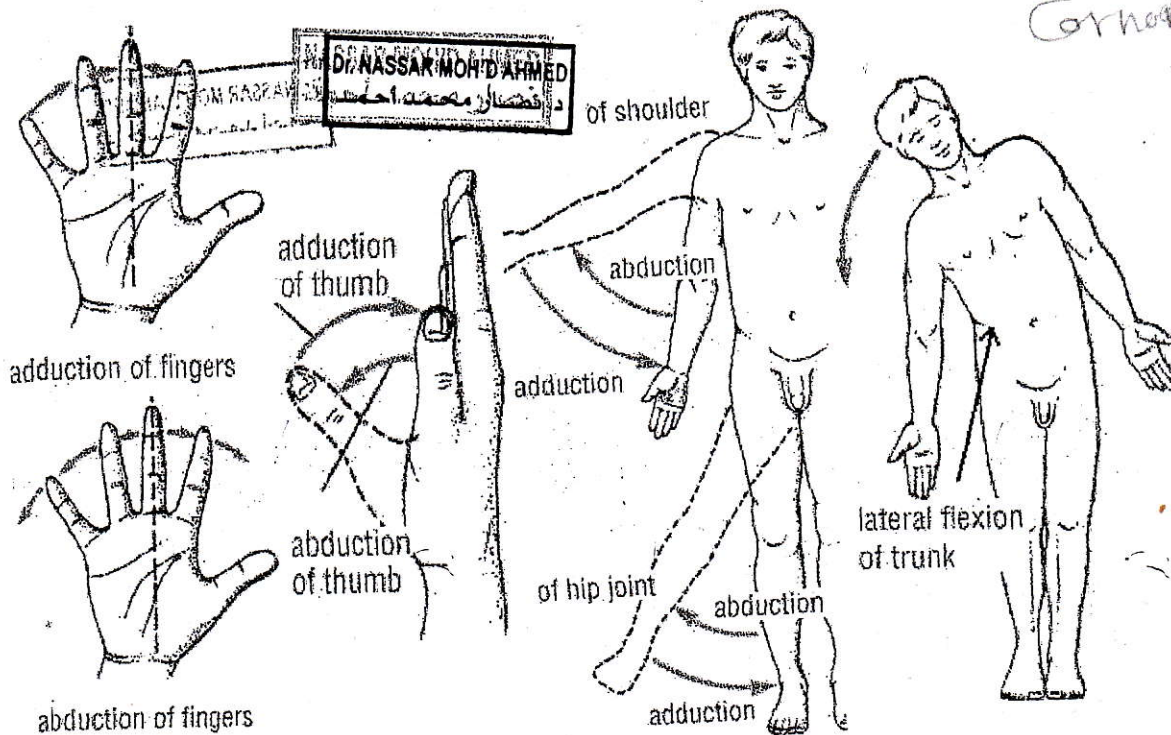
Sagittal Plane:



2. Around the vertical axis: rotatory movements (rotation). In forearm and hand medial rotation is called **pronation** and lateral rotation is called **supination**.



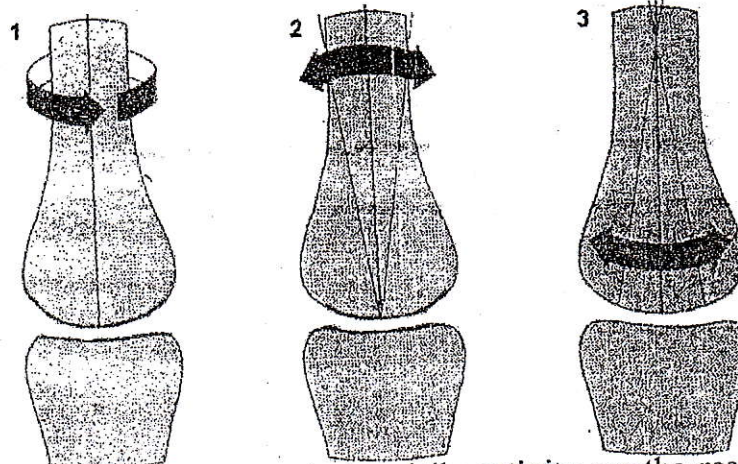
3. Around the **sagittal axis**: **lateral inclination** in the trunk and **adduction** (rapprochement) and **abduction** (separation) at the limbs.



4. **Special movements**: actually, during normal function of the joints, the performed movements are complex due to a combination of three

basic actions:

- 1 • Spin
2 • Roll
3 • Slide



Thus, normal active articular movements during daily activity are the result of a combined action, and rarely are pure movements around a specific axis. They are performed around more than one axis passing smoothly from one to another.

4-1. Circumduction: free movement around all axes, from one to another

4-2. Opposition of thumb: due to the special characteristics of the first metacarpo-phalangeal joint, the thumb is able to touch the tip of the rest of the fingers.

4-3. Inversion of foot: rotates the plantar surface inwards.

4-4. Eversion of the foot: rotates the plantar surface outwards.

4-5. Depression: lowering a body part.

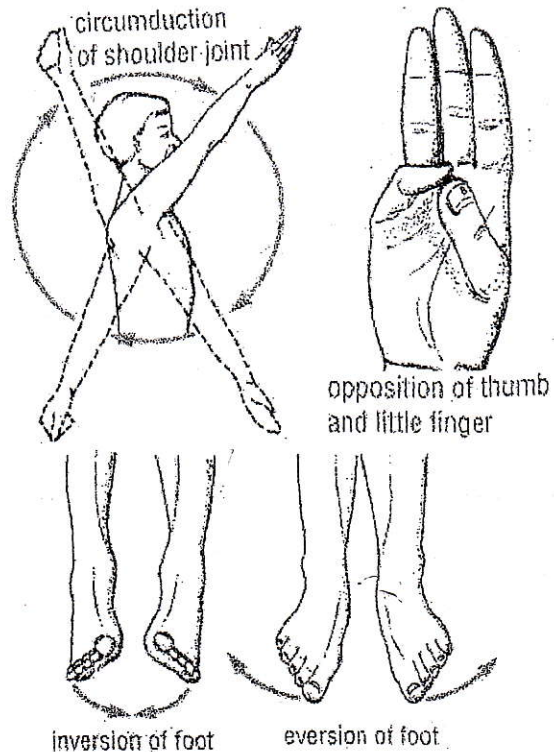
4-6. Elevation: raising a body part.

4-7. Protraction: forward movement.

4-8. Retraction: backward movement.

4-9. Lateral displacement.

Examples of the last five can be appreciated in the mandible movements.

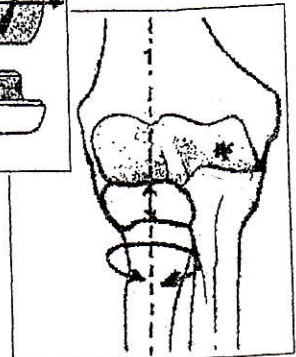
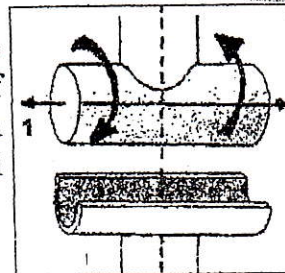


Classification of the Synovial joints according to the shape of the articular surfaces and the axes of movements

The geometric shape of the articular surfaces determines the type and to some extent, the range of the joint. The axes of movement at the joint contribute to its classification and indicate the degrees of freedom in articular movement.

Uniaxial: movements around one axis, in one plane.

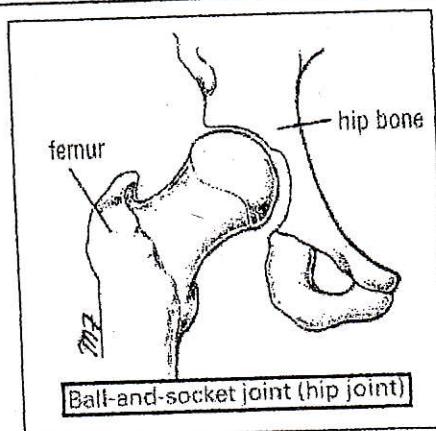
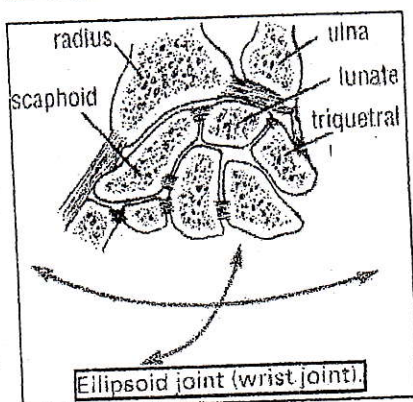
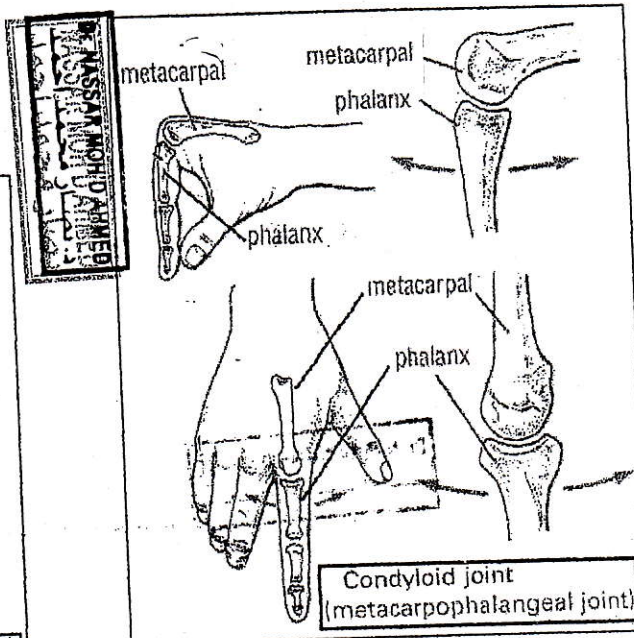
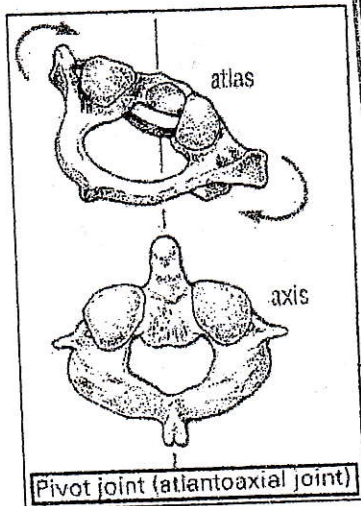
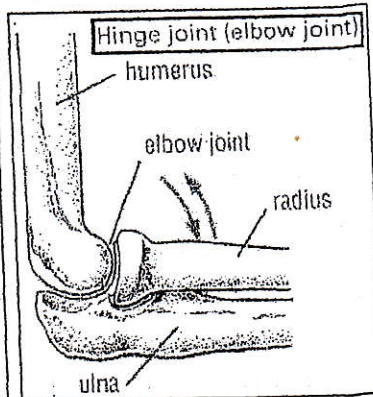
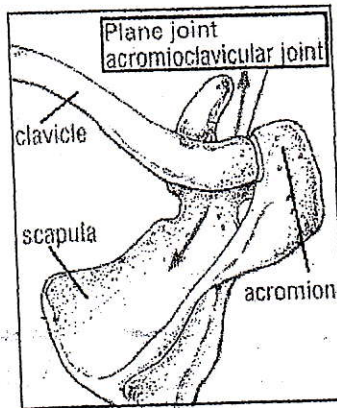
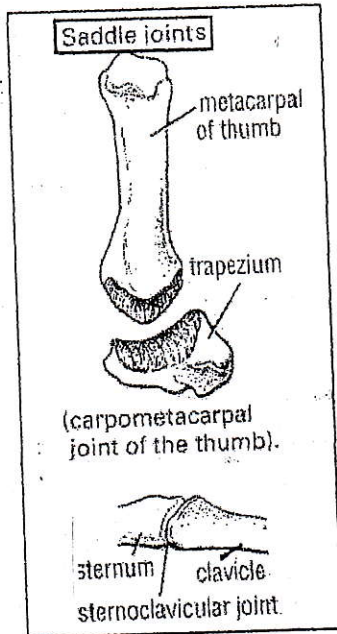
- **Ginglimus or hinge joint:** it has a single (1) axis perpendicular to the long axis of the bones and allows flexion-extension movements. Examples: interphalangeal joints, humero-ulnar joint.
- **Trochoid, pivot or wheel joint:** it has a single axis (1) parallel to the axis of the articulating bones, allowing rotatory movements. Examples: proximal radio-ulnar joints, median atlanto-axial joint



Dr. NASSAR MOH'D AHMED
د. ناصر محمد أحمد

Classification
according
to the
shape

SOME EXAMPLES OF TYPES OF SYNOVIAL JOINTS ACCORDING TO THE ARTICULAR SURFACE SHAPE

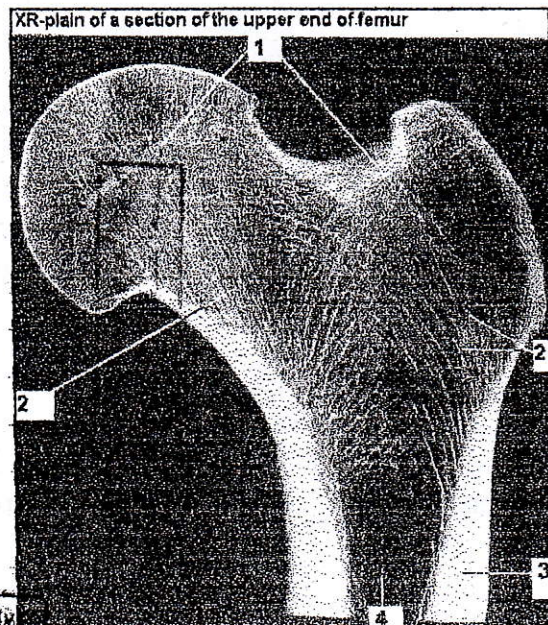


RADIOLOGICAL ANATOMY OF THE SKELETON

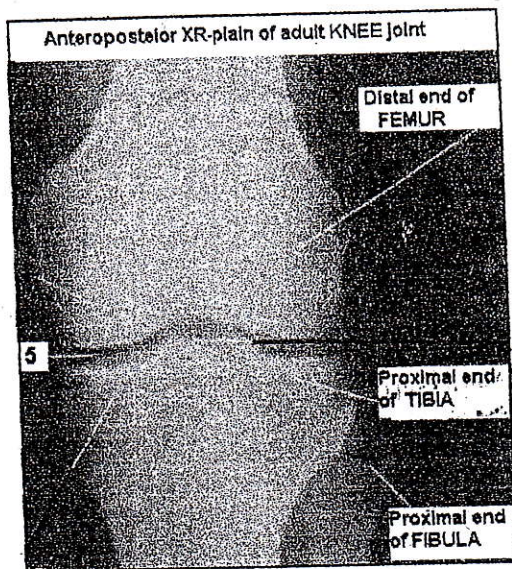
The bones can be easily studied on radiographs because the osseous tissue has normally the capacity to absorb the X-rays more than other tissue. This property is called **radio-opacity** while the opposite (to allow pass them freely) is called **radio-transparency**. It depends on the **density** of the tissue.

As more radio opacity (density) shows a structure as whiter or paler its image appears on XR-plains.

We can identify any bone for its external shape or contour on simple RX-plains of the skeleton. Also the different types of elevations (where muscles and ligaments attach) can be identified on the bony surface because these places show greater opacity due to higher calcium content. And even the gross internal structure is clearly seen: the **compact bony** (3) appears as a *white line* of varying thickness in contrast to the **spongy bony** (2) which shows a *lace-like appearance*. The **medullar cavity** (4) appears *darker*.



It is possible to recognize some age changes of the skeleton. During the grow period the **epiphysial cartilage** appears as a translucent band across a bone and later, its **fusion-line** (1). This radiological feature of the bony structure is very important because unfused epiphyses can sometimes simulate fractures. In the senile or post-menopausal period certain account of spongy bone trend to be destroy because of the normal loss of calcium and phosphorus: it is called **osteoporosis**. And some soft tissues attached to the bones like ligaments and cartilages become into radio-opacity structures because of an abnormal bony outgrowth (they suffer an ossification process): they are called **osteophytes**. Age changes are common in many joints, more particular those concerned with weight bearing like in the vertebral column.



Of course, the different types of joints can be identified on XR-plains of the skeleton: fibrous, cartilaginous and synovial joints.

Then, you will be able to recognize some sutures of the skull and cartilage discs between the vertebrae. But concerning this, the most important for your future medical practice is the radiology of synovial joints (see one example in the picture on the left) because their affectations like arthritis, dislocations, etc, are very frequent.

Sometimes it is necessary the introduction of contrast medium (ear or iodine substance) to allow seeing the articular cartilages (e.g. in knee joint) because cartilage has a density similar to that of other soft tissues, so that, they appear as part of the radiological 'joint-space' (5).



GUIDE FOR PRACTICAL CLASS # 1

Theme: INTRODUCTION TO HUMAN ANATOMY GENERAL OSTEOLOGY AND ARTHROLOGY

Summary:

1. Methods and ways of study in Anatomy.
2. Primary division of the human body. Cavities and membranes of the body.
3. Nomenclature or terminology in anatomy:
 - Anatomical position.
 - Planes of section.
 - Principal axes.
 - Directional terms.
4. Parts of a typical bone. Bony surface features.
5. Classification of bones.
6. Classification of joints.
7. Main features of a synovial joint. Movements.

Objectives:

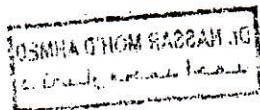
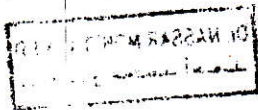
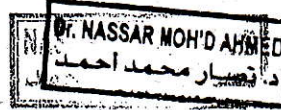
1. To know the main concepts of the international anatomical terminology pointing out the more important regions of human body and emphasize the terms of orientation more used for this purpose.
2. To know the general aspects of the bones and joints (locomotor apparatus) and general concepts concerning skeleton.
3. To identify the main features of a typical bone.
4. To identify the main features of a typical synovial joint.
5. To classify bones and joints according to the International Nomina Anatomical.

Methodological orientation (TASKS)

1. We want to advise you that most of the times students do not pay enough attention to the generalities or introductory information. It is great mistake! So that, you should read it carefully, because this theme is very useful and necessary for your further works as medical student. Mainly, you should know very well all concerning the nomenclature or terminology in Anatomy.
 - a) Reproduce yourself the anatomical position.

- b) Reproduce the planes of section and the principal axis in any plastic model or draw them in your notebook.
- c) Practice the directional terms (fig. 1.1 of textbook and page IX of the Atlas).

2. Draw any typical bone (long) and identify its parts and markings (fig 6 of the Atlas).



- 3. Classify the bones, which are on the table according to the shape.
- 4. Try to identify each bone in the skeleton (fig. 3.7 and 3.8 of the book) précising the regional location. Example:
 Clavicle → appendicular skeleton → upper limb/shoulder girdle
 Femur → appendicular skeleton → lower limb/thigh
 Sacrum → axial skeleton → vertebral column
 Frontal → axial skeleton → skull



5. Identify the main parts present in any typical synovial joint (fig 4.5 and 4.7 of textbook).

- Label them on the picture in the first page.

6. Give example of each type of joint and mainly, of each type as synovial joints according to the structural and functional classifications (number of articular surfaces, shape of articular surfaces and axes of movements).

- Try to identify or recognize most of the types in the specimens or in your own body.
- Label the types present in the drawing of the skeleton of the hand in the first page.

7. Perform yourself the possible movements of the synovial joints around the axes.

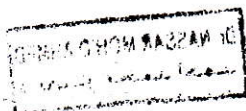
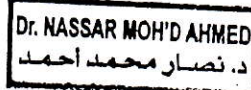


8. In x-rays planes, identify:

- Some parts of a typical bone and some markings.
- Spongy and compact substance.
- Any articular region or joint (see fig. 139 in page 71 of the Atlas).

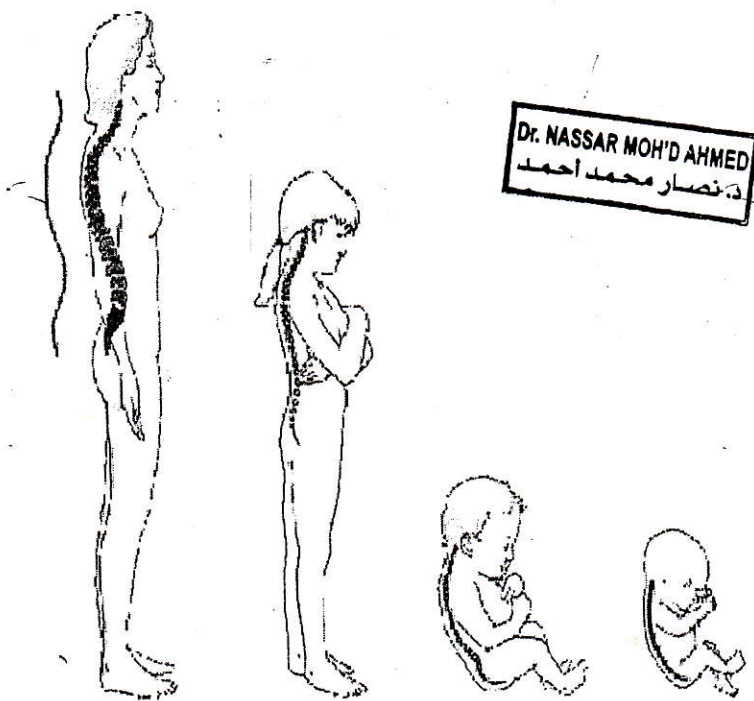
Bibliography

- Cunningham's textbook of Anatomy. 12th edition. Pages 1-3, 75-88 and 211-220.
- Sobotta/Figge. Atlas of Human Anatomy. Vol 1. Pages VIII, IX and 1-9.

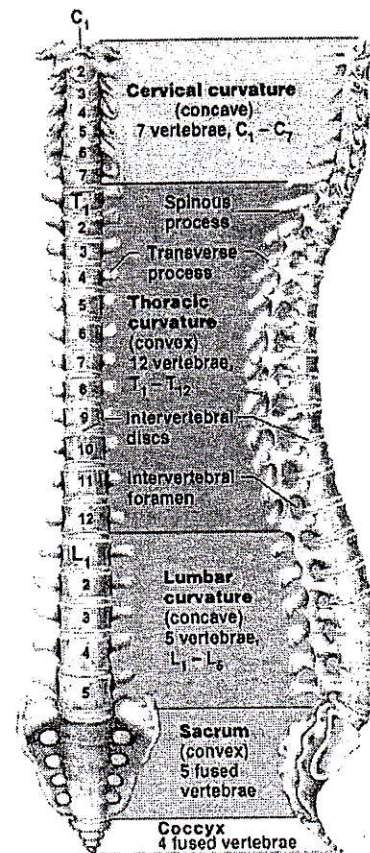


SKELETON of the TRUNK

Part I: Vertebral column



(Lecture # 3)



Anterior view

AXIAL SKELETON: DEFINITION, COMPONENTS

The axial skeleton is defined as the part of the skeleton located at the main (principal or vertical) axis of the body, formed by the skull, the vertebral column, and the thoracic cage (ribs and sternum).

SKELETON OF THE TRUNK: VERTEBRAL COLUMN AND THORAX CAGE

The vertebral column is the dorsal bony axis of our body. It extends along the dorsal midline of the neck and trunk, from the cranial base, to the pelvis.

FUNCTIONS:

1. Support of the body weight, transferring it to the lower limbs through the sacro-iliac joints.
2. Protection of the spinal cord, which is lodged within the vertebral canal and of the thoracic viscera, which are lodge within the thoracic cage.
3. Movements of the neck and trunk, including respiratory movements.

STRUCTURE:

The vertebral column is formed by an average number of 32-34 irregular bones, each one called **vertebra**, which are successively articulated to one another, forming a curved stick.

The first 24 vertebrae are independent bones connected by joints including fibro-cartilaginous plates between the vertebral bodies called **intervertebral discs**. The rest are fused to form two single bones, the **sacrum** and the **coccyx**.

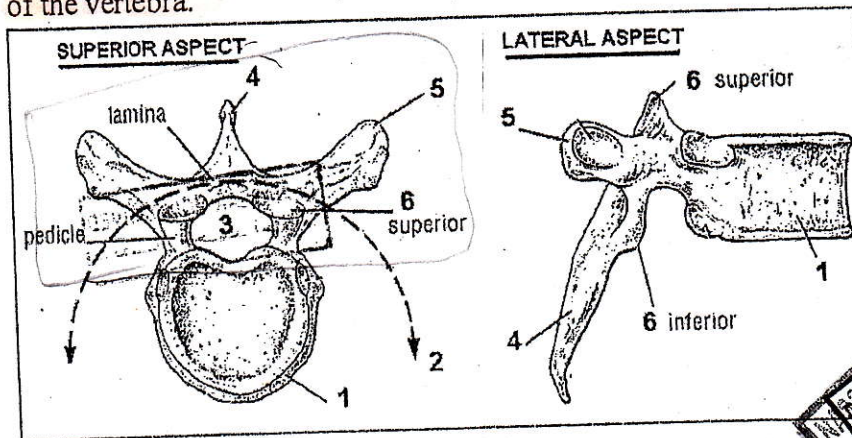
The vertebral column is divided into five regions: cervical, thoracic, lumbar, sacrum, and coccyx. Each region consists of a definitive number of vertebrae as follows:

- Cervical → 7
- Thoracic → 12
- Lumbar → 5
- Sacrum → 5 (fused in adult peoples)
- Coccyx → 3-5 (fused in adult peoples)

COMMON FEATURES OF A TYPICAL VERTEBRA

These are a number of anatomical characteristics, which are present in most of the vertebrae. (We consider "typical" vertebra any thoracic vertebra from T2 to T8.)

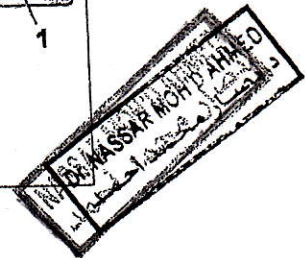
- 1 **Body:** anterior cylindrical portion with a superior and inferior articular surface for the joining to adjacent vertebra by the intervertebral disc. The body is the supporting portion of the vertebra.
- 2 **Vertebral arch:** posterior, curved portion attached to the posterior side of the pedicles, and completed posteriorly by two small, flat pieces called laminae. Arch and body form:
- 3 **Vertebral foramen:** with encloses the spinal cord and its meninges. Thus, the vertebral arch is the protecting portion of the vertebra.



From the vertebral arch, a number of processes arise:

4. **Spinous process:** directed backwards from the junction between the two laminae (single).
5. **Transverse processes:** extended laterally from the junction between the pedicle and lamina of each side (paired).
6. **Articular processes:** two pairs, superior (a) and inferior (b). Each one has its corresponding articular facet to joint with the adjacent vertebra.

Spinous and transverse processes give attachments to muscles and ligaments. Articular processes form synovial intervertebral (cygapophyseal) joints. Then, processes are the portions of the vertebra mainly related to movement.

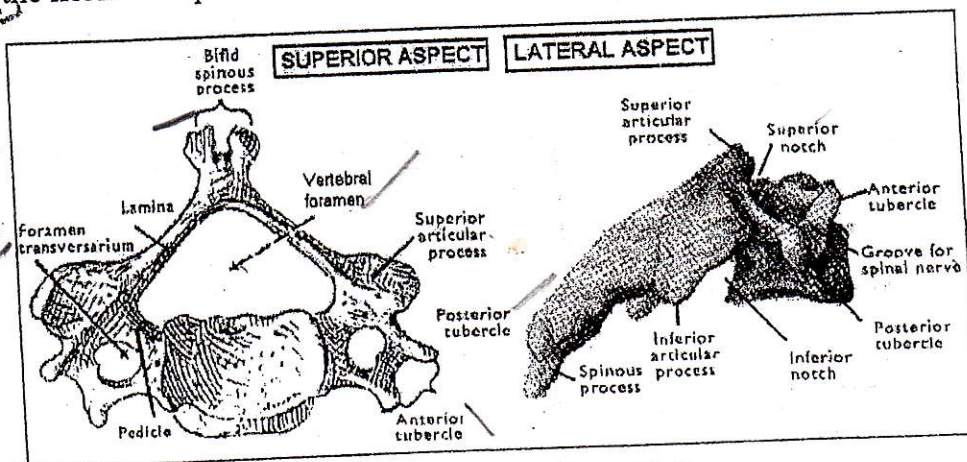


REGIONAL CHARACTERISTICS OF THE VERTEBRAE

These are the anatomical features which characterize a vertebra of a definitive region of the vertebral column and allow differentiating this vertebra in comparison to others from other regions of the vertebral column. To describe the regional characteristics of the vertebra, we choose one of the typical (central) vertebra of each region. The vertebrae situated at the extremities of each region show transitional characteristics of both neighboring regions and are considered atypical.

Regional characteristics of a typical cervical vertebra

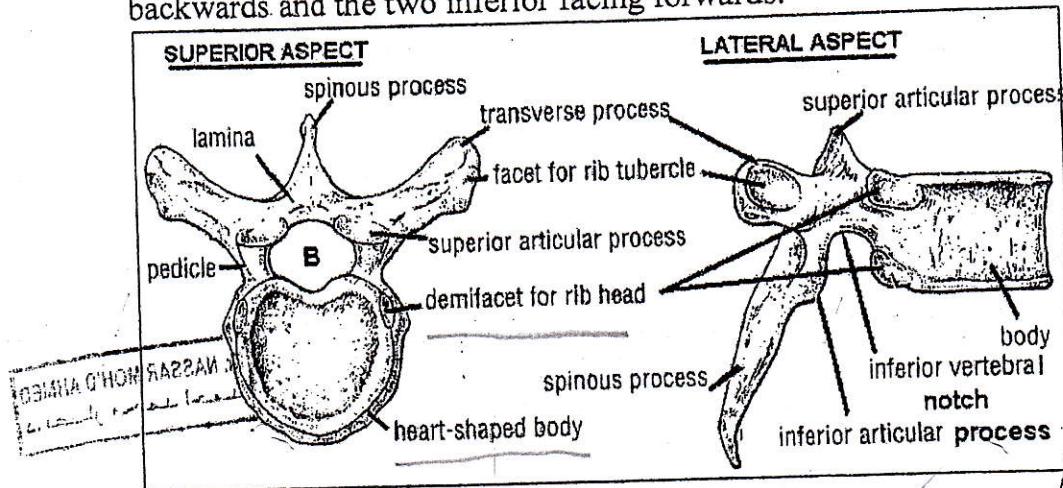
- **Body:** small size, quadrangular shape. Superior surface is lipped up at the sides, and the inferior surface at the front and at the back.
- **Vertebral foramen:** triangular in shape and large in comparison with the size of the whole vertebra.
- **Spinous process:** short and bifid.
- **Transverse processes:** the presence of a transverse foramen (through which vertebral vessels pass). Also, the tip of the transverse process is divided into anterior and posterior tubercles.
- **Articular processes:** articular facets flat, situated almost in the horizontal plane.



Regional characteristics of a typical thoracic vertebra

- **Body (B):** heart-shaped. They show an intermediate size between the small cervical and the large lumbar. At both sides, near the pedicles, we find two, a superior and inferior semi-facet (half) to join with the head of the ribs.
- **Vertebral foramen:** rounded.
- **Spinous process:** large, narrow, and pointed. Obliquely directed backwards, overlapping to each other.

- منظر
- **Transverse processes:** large, and club-shaped. Near its tip, at the anterior surface, we find an **articular facet** to join with the tubercle of the corresponding rib.
 - **Articular processes:** vertically placed. The articular facets in the frontal plane and flat. The two superior facing backwards and the two inferior facing forwards.

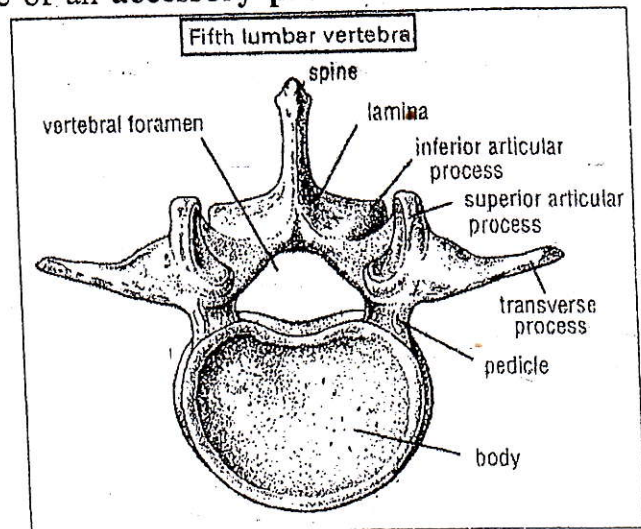


Regional characteristics of a typical lumbar vertebra

- **Body:** large, kidney-shaped.
- **Vertebral foramen:** triangular, but small in comparison with the size of the whole vertebra.
- **Spinous process (spine):** wide, flat, quadrangular, directed backwards in the sagittal plane.
- **Transverse processes:** narrow and pointed, directed laterally.

Actually, they represent the costal element at the lumbar region. It must be pointed out the presence of an **accessory process** at the root of the transverse process.

- جانبي
- عربي
- **Articular processes:** The superior articular facets are concave, facing medially. The inferior articular facets are convex, facing laterally. Both superior and inferior facets are situated at the sagittal plane. Something peculiar here is the presence of a **mamillary process** at the tip of superior articular processes.



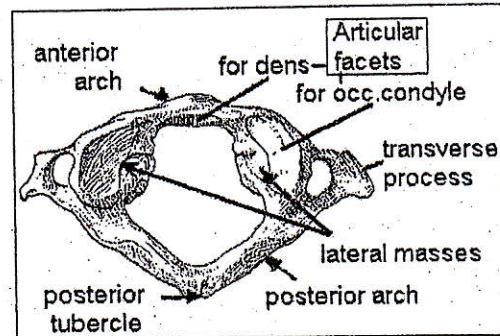
superior articular processes.

INDIVIDUAL CHARACTERISTICS OF ATYPICAL VERTEBRA

First cervical vertebra (Atlas):

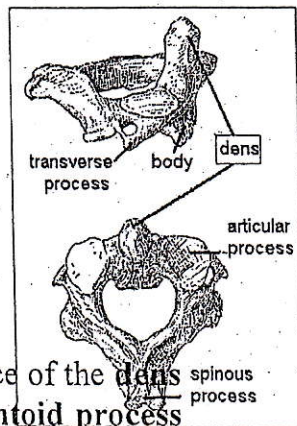
- Absence of body.
- **Anterior and posterior arches** joined by two lateral masses.
- Superior and inferior articular facets in the lateral masses (the superior facet is like a sandal). And other facet for the dens of axis at the
- Transverse process is very small.
- **Posterior tubercle** instead of spinous process.

posterior aspect
of the anterior
arch.



The superior articular facets or surfaces articulate with the occipital condyles. The inferior articular surfaces articulate with the corresponding superior articular surfaces of the axis (lateral atlanto-axial joints). The anterior arch joins to the dens of axis (median atlanto-axial joint).

Second cervical vertebra (Axis):



- Presence of the **dens** or odontoid process

on the upper surface
of the body.

- An articular facet on the anterior aspect of the dens.
- Small transverse process. There is no anterior tubercle.
- Spinous process thick and strong, with a bifid tip.

Anterior aspect



Posterior aspect

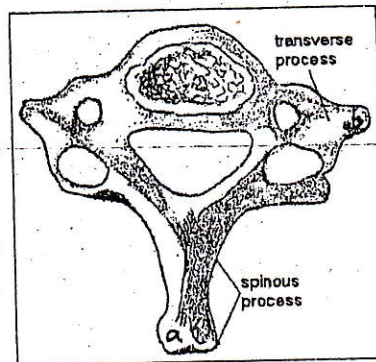


Dr. NASSAR MOH'D AHMED

د. نزار محمد أحمد

Seventh cervical vertebra (Vertebra prominens):

- It has a long spinous process visible at the lower end of the nuchal furrow. It ends in a prominent tubercle (a) for the attachment of ligamentum nuchae.
- Transverse processes with small transverse foramen, prominent posterior



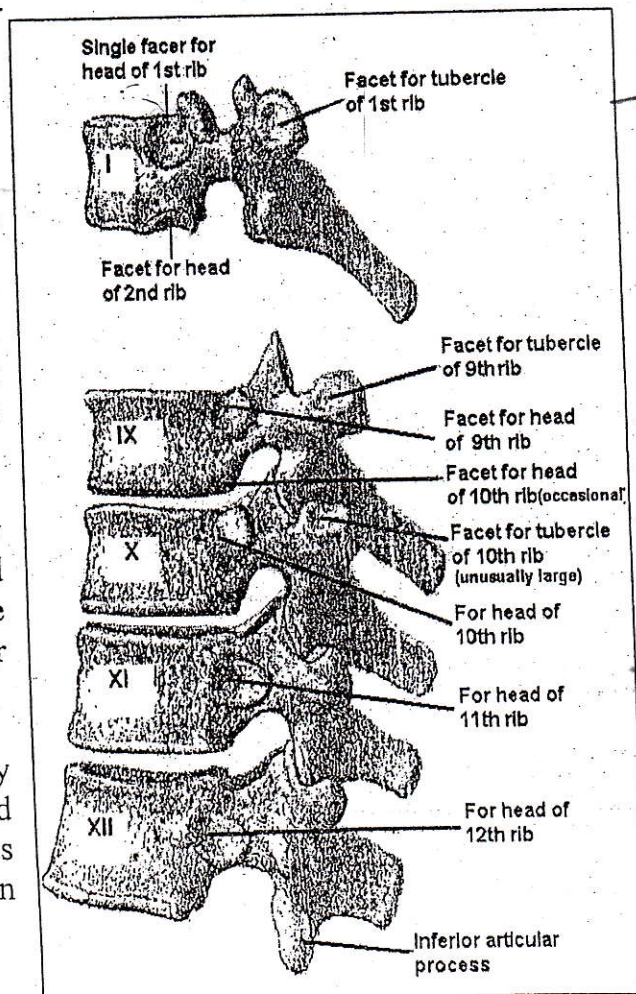
Atypical thoracic vertebrae: 1st, 10th, 11th and 12th.

First thoracic vertebra: shows a complete upper facet for the whole head of the first rib and a small, lower semi-facet for the second rib. Besides, it exhibits a prominent spinous process.

Tenth thoracic vertebra: only shows a complete upper facet for the head of the 10th rib and the articular facet on the transverse process is unusually large.

Eleventh thoracic vertebra: only shows a complete facet for the head of the 11th rib, situated almost at the pedicle and do not show articular facets on the transverse processes.

Twelfth thoracic vertebra: only shows a complete facet for the head of the 12th rib, near to the pedicles and do not show articular facet on the transverse process



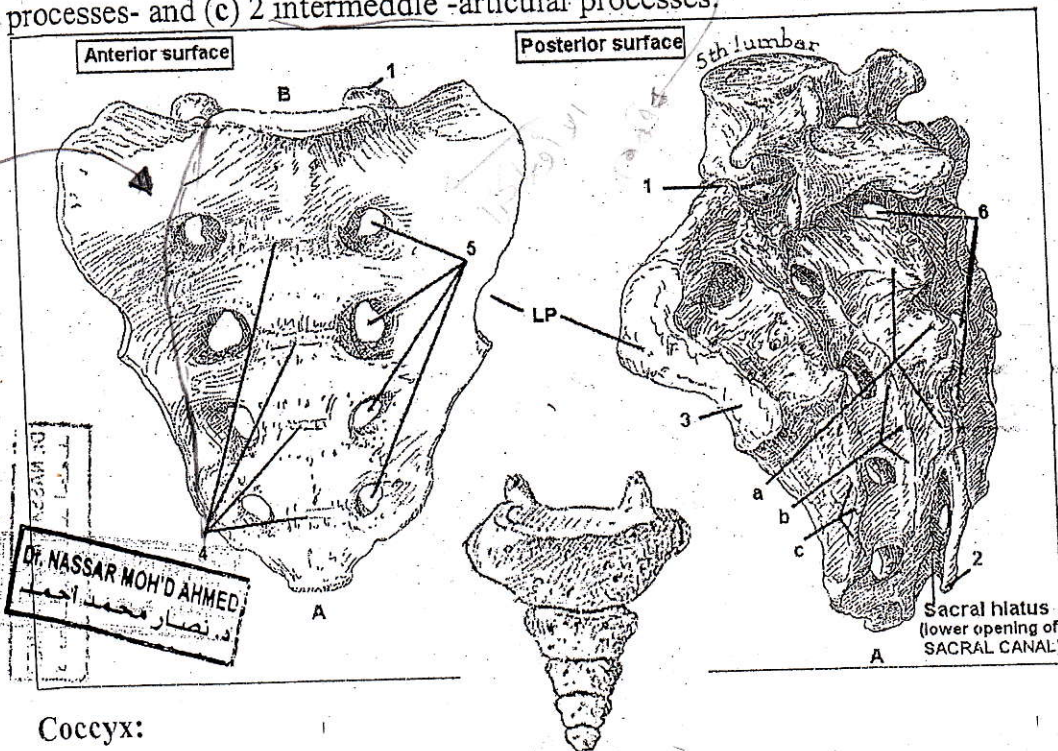
Lumber
pundition

Sacrum:

It is a single bone formed by the fusion of the five sacral vertebrae and their corresponding intervertebral discs. By this way, the sacrum provides strength and stability to the pelvis and transmits the weight of the body to the pelvic girdle through the sacro-iliac joint. It is pyramidal-shaped, with a **base (B)** directed upwards and forwards, an **apex (A)**, which is directed downwards, an **anterior or pelvic surface**, concave and relatively smooth, a **posterior or dorsal surface**, convex and rough, and two **lateral portions or alae of the sacrum (LP)**.

The base and **superior articular processes (1)** of the sacrum join to the fifth lumbar vertebra. The apex and **sacral corn (2)** join to the coccyx. Seen from lateral aspect we can identify the **auricular surfaces (3)** to join to similar surfaces of the iliac bones.

In the anterior surface we can observe the **transverse lines (4)**, traces or intervertebral discs, and at both sides four pairs of **anterior foramina (5)**, to allow spinal nerves exit from the **sacral canal**. Posteriorly, these foramina also can be observed (6) and **5 sacral crests** due to the fusion of the processes: (a) 1 median -spinous processes-, (b) 2 lateral -transverse processes- and (c) 2 intermeddle -articular processes-.



Coccyx:

It is a rudimentary bone formed by 3 to 5 more or less fused coccygeal vertebrae. The first one presents a superior articular surface and two **cornua** to join with similar structures of sacrum. The rest coccygeal vertebrae become progressively featureless.

JOINTS OF THE VERTEBRAL COLUMN

We can find all types of joints at vertebral column.

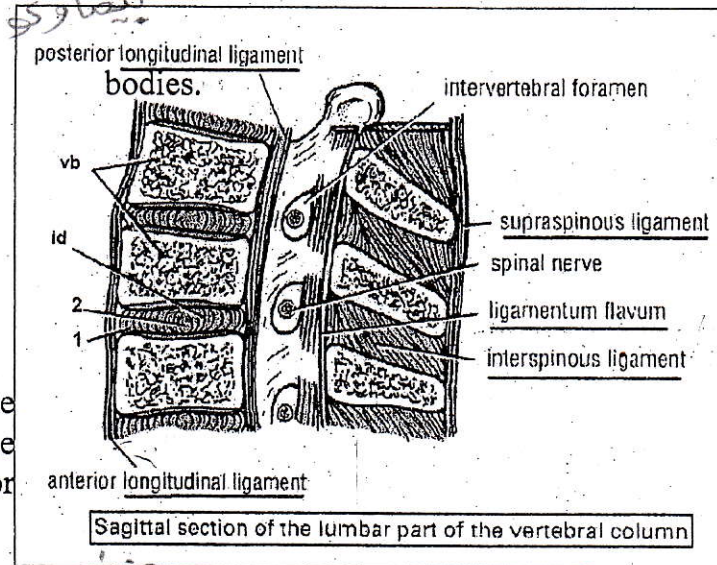
A. Joints between vertebral bodies (vb): intervertebral discs (id).

They are cartilaginous joints, type symphysis.

Each disc is formed by an oval plate of fibro cartilage comprising two parts:

1. Anulus fibrosus (peripheral)
2. Nucleus pulposus (central)

A thin layer of hyaline cartilage covers the superior and inferior surfaces of the vertebral



Two longitudinal ligaments reinforce these joints along whole column:

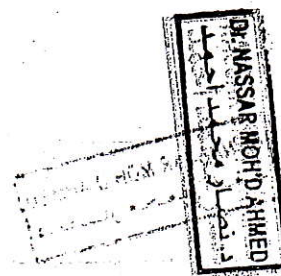
- Posterior longitudinal ligament: from axis to sacral canal, mainly attached to intervertebral discs, along whole length of the anterior wall of the vertebral canal.
- Anterior longitudinal ligament: from atlas to sacrum, attached to vertebral-bodies.

B. Joints between arches:

1. Intervertebral joints (zygapophyseal): between articular processes. They are synovial, plane of gliding type.

2. Accessory ligaments:

- Interspinous: between adjacent vertebral spines, strongest at the lumbar region (see it above).
- Supraspinous: over the tips of the spines, fused with the interspinous as nuchal ligament in the neck (see it above).
- Intertransverse: between transverse processes. Only well develop at lumbar region where they help to strengthen.



- Ligamenta flava (yellow ligaments): between laminae. The only marked (true) elastic ligaments in man, which help in maintaining erect posture (see it above).

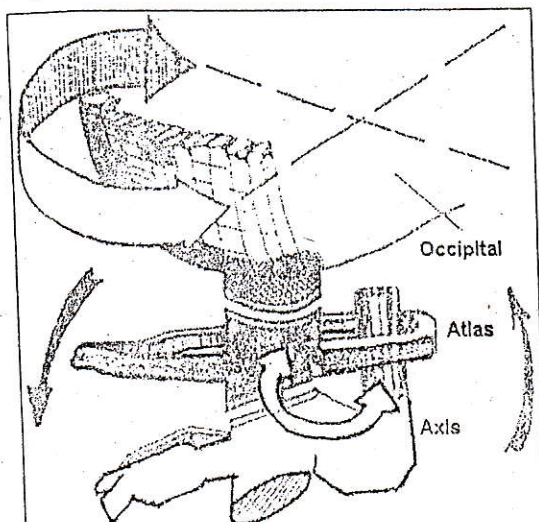
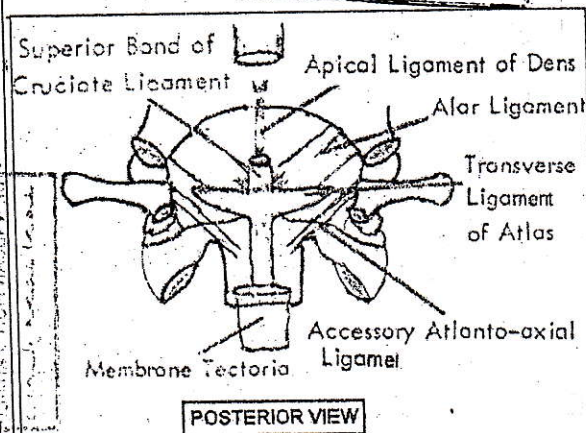
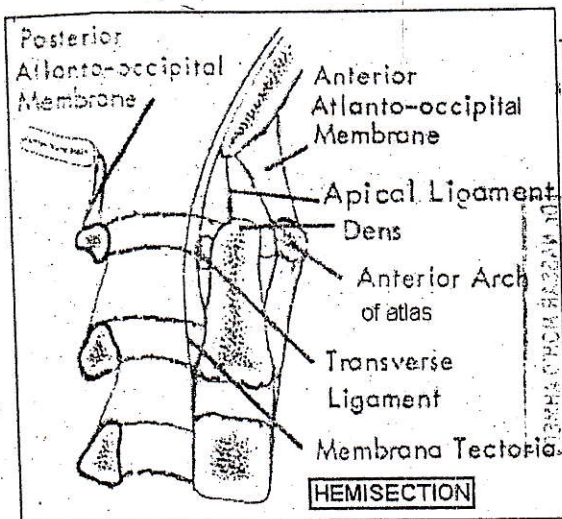
C. Joints between the head and the cervical vertebrae

The skull is joined to the atlas by a pair of atlanto-occipital joints (synovial-ellipsoid or condyloid). They are established between the occipital condyles and the superior articular surfaces of the atlas.

The atlas and the axis are joined by three joints (→ see pictures page 6):

- a) Median atlanto-axial joint: between the anterior arch of atlas and the dens or odontoid process of axis. It is classified as synovial type trochoid.
- b) Lateral atlanto-axial joints: common intervertebral joints between articular processes. It is classified as synovial type plane.

In the following drawings you can appreciate the complexity of the disposition of their ligaments as well as analyze the possible combination of movements.



Movements of the head at the atlanto-occipital joints:

- Nodding or bending the head forwards and backwards.
- Lateral nodding.

The combined movements of the three **atlanto-axial joints** produce:

- Rotation of the head around the vertical axis → the skull and the atlas move simultaneously in this case.

Condyle
odontoid

VERTEBRAL COLUMN AS A WHOLE

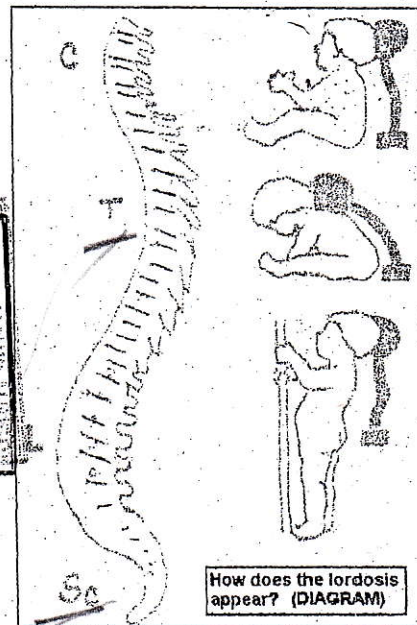
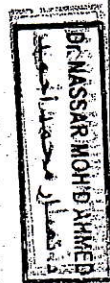
- The vertebral column has four antero-posterior curvatures (in the sagittal plane).

Primary curvatures: they appear during intra-uterine life. They are concave ventrally called **kyphosis**.

- **Thoracic kyphosis** is the fundamental curvature from an early stage.
- **Sacro-coccygeal kyphosis** is an additional curvature that appears at about the 5th month of intra-uterine life to accommodate the pelvic viscera.

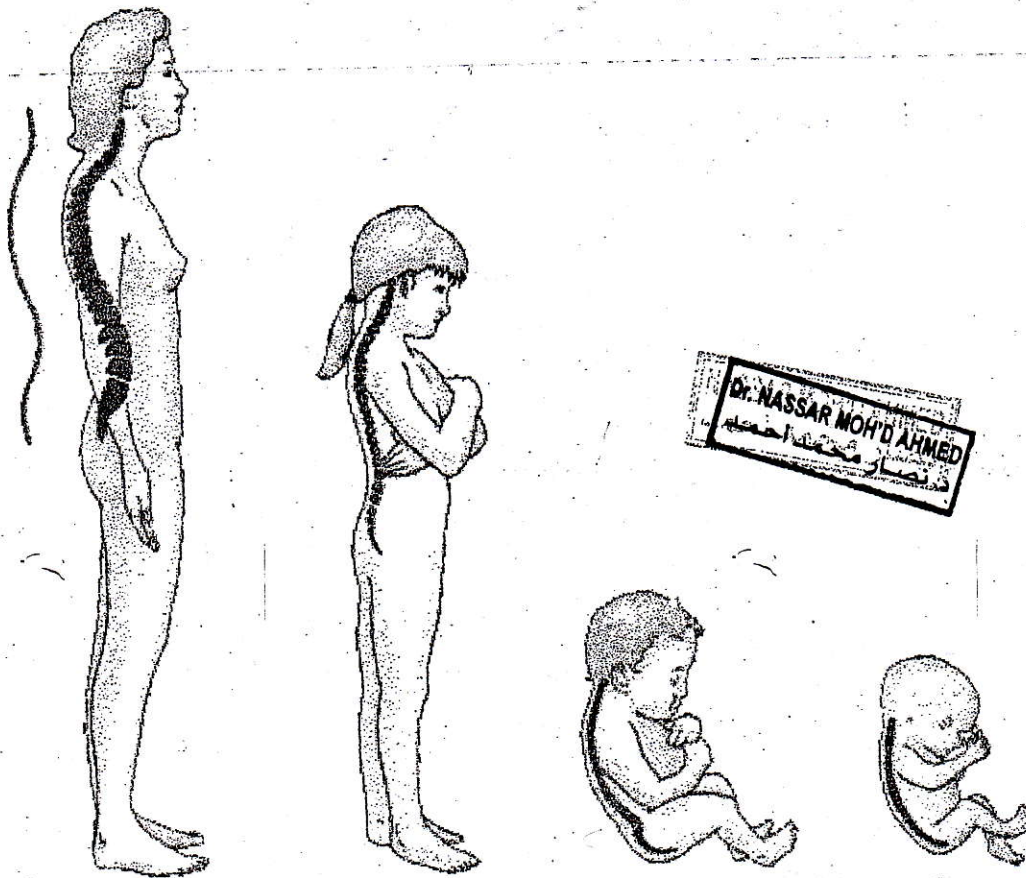
Secondary curvatures: they appear after birth. They are convex ventrally called **lordosis**.

- **Cervical:** as the head is raised from the thorax in the first few months after birth.
- **Lumbar:** it develops later, towards the end of the first year, when the child starts with a sitting posture, followed by an upright walking posture.



When erect, the alternative curves of the vertebral column provide for absorption of vertically directed shocks. These are not transmitted straight through the column but are absorbed by the intervertebral discs and by slight bending of the curvatures which is maintained by muscles and ligaments.

الذو 1



The vertebral column has also lateral curvatures in the frontal plane called **scoliosis**. They are mainly postural in its development. In right-handed subjects there is usually a slight convexity to the right in the thoracic region. Compensatory convexities appear subsequently to the left in the cervical and lumbar regions. Scoliosis are normal curvature, nevertheless pathological conditions may lead to an increase in their degree-of-convexity.

- The vertebral column varies in length but is about 70 cm in man and 60 cm in woman.
- The vertebral bodies increase in size from the skull down to the point where the weight of the body is passed from the sacrum to the pelvic girdle (sacro-iliac joint), and then diminish rapidly.
- Posteriorly, the spinous processes project to a varying degree and are palpable in the midline from the seventh cervical (vertebra prominens) down to the sacrum and coccyx. The thoracic spines overlap to each other to avoid excessive extension of the column (protection to thoracic viscera and great vessels).
- The sacrum forms a bony link between the two iliac bones. The anterior border of sacral base projects forwards forming a bony prominence called **promontory** which receives the body weight from the upper portion of the vertebral column.
- The **vertebral groove** is the wide furrow alongside the spinous processes, between them, the laminae, the articular processes, and the transverse processes.

Movements of the vertebral column as a whole

The movements between any two successive vertebrae (each pair of vertebrae) are very slight, mainly of the gliding type; but **the total sum** of movement in the whole column is considerable due to two main factors:

- Elasticity of the intervertebral discs.
- Laxity of the capsule of the synovial intervertebral joints between articular processes.

The movements of the vertebral column are customarily described as:

1. Forward → Flexion
2. Backward → Extension
3. Lateral flexion
4. Rotation



These two last movements always take place associated; never can take place independently of the other.

The direction and range of movements in the different regions are largely determined by the thickness of the intervertebral discs and the disposition and shape of the articular processes.

- Cervical region: extensive movements due to discs relatively thick and flat facets in articular processes.
- Thoracic region: limited movements due to thin intervertebral discs, presence of ribs and sternum and overlapping of spinous processes.

- Lumbar region: thick intervertebral discs allow free flexion and extension and the sagittal disposition of the articular processes allow rotation.

GUIDE FOR PRACTICAL CLASS # 2

Theme: Skeleton of the trunk.

Summary: Bones and joints of the vertebral column.

1. Vertebral column: definition, situation, structure, and division.
2. Typical vertebra: position, features.
3. Common regional characteristics of the vertebrae.
4. Atypical vertebrae: atlas, axis, etc.
5. Sacrum and coccyx bones.
6. Joints between vertebrae.
7. Joints between vertebrae and the skull.
8. Vertebral column as a whole: curvatures, movements.

Objectives:

1. To describe the general characteristics of the bones of the vertebral column using a typical vertebrae.
2. To identify and describe the common regional characteristics of the vertebrae, including sacrum and coccyx bones.
3. To identify some vertebrae for their individual characteristics: atlas axis, 7th CV, 1st TV, 11th TV, 12th, etc.
4. To identify and classify the joints of the vertebral column as well as explain the movements provided for these joints.
5. To describe and identify the features of the vertebral column as a whole: regions, curvatures, movements, etc.
6. To identify the anatomical details through the surface of the body and in radiographs (simple XR-plains).

Methodological orientation (TASKS):

1. Precise the general characteristics of the bones in the vertebral column. **Take into account the general orientation about osteology** and use one typical vertebra (it means a vertebra situated in the central part of the column). Use the figures 32 and 34 of the Atlas. Now, try to answer why or why not is "this bone" a vertebra?
2. In a group of vertebrae, identify :

- Any typical cervical vertebra (fig. 28)
- Any typical thoracic vertebra (fig. 32)
- Any typical lumbar vertebra (fig. 36-38)

→ Take into account the **common regional characteristics** of the vertebrae.

3. Now, apply your knowledge about the **individual characteristics** of some atypical vertebrae and show **atlas** and **axis** (fig. 22-27) and try to recognize 7th CV, 1st TV, 11th TV and 12th TV.

4. Identify and describe **sacrum** and **coccyx** (fig. 39-45) attending to: name, identification, the anatomical position, situation in the body, classification, portions and osseous details.

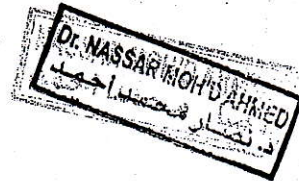
5. Indicate in the skeleton, the joints of the vertebral column and thorax, mentioning the names and classifications.

In order to organize these, you may use the following:

- Joints of vertebral column {
 - between the vertebral bodies
 - between the vertebral arches
- Joints of the vertebral column and skull (cranio-vertebral joints)

6. In one segment of the vertebral column or in the fig 197.

- The intervertebral disc.
- The longitudinal ligaments
- The joints between the articular processes
- The ligamentum flavum (lig. Flava)



7. Practice the movements of the vertebral column.

8. **Surface and radiological anatomy of the vertebral column.**

- Palpate the spinous processes of the thoracic vertebrae taking as references the vertebra prominens (7th cervical).
- In frontal and lateral X-rays planes of the vertebral column, identify: intervertebral discs, vertebral bodies, intervertebral foramina, spinous and transverse processes, joint between articular processes, etc.

9. Do not forget to study the "vertebral column as a whole". Show in an articulated spine some of its features like curvatures, shape, etc

Bibliography:

- Cunniggham's textbook of Anatomy. 12th edition. Pages 89 to 102 and 220 to 224.
- Sobotta/figge. Atlas of Human Anatomy. Vol 1. Page 15-27 and 94-103.
- You can use Practical Anatomy I' booklet. Pages 4 to 10.

SELF-ASSESSMENT ACTIVITIES

1. Fill the following comparative table:

	CERVICAL	THORACIC	LUMBAR
Body			
Vertebral foramen			
Spinous process			
Transverse Process			
Articular process			
Other feature			

2. Make a relation of the different joints we can find in the vertebral column and classify them.
3. Analyze and discuss the following statements:
- The human sacrum is a single bone because of our biped-station.

- We can observe all the curvatures in the vertebral column of a newborn.
- The longitudinal ligaments of the vertebral column play an important roll.
- We can find in our vertebral column vestiges or traces of the three development stages it has passed through.
- Pathologies of the vertebral column are very rarely.

DR. NASSAR MOH'D AHMED
د. ناصر محمد أحمد

DR. NASSAR MOH'D AHMED
د. ناصر محمد أحمد

DR. NASSAR MOH'D AHMED
د. ناصر محمد أحمد

~~Data of the sacrum~~
~~(X)~~

RADIOLOGICAL ANATOMY OF TRUNK SKELETON

The **vertebral column** can be studied taking antero-posterior, lateral and oblique radiograph. It is very important to take into account the age of the patient to interpret them properly. They are more frequently performed at the cervical and lumbar regions.

In an antero-posterior XR-plane is possible to identify:

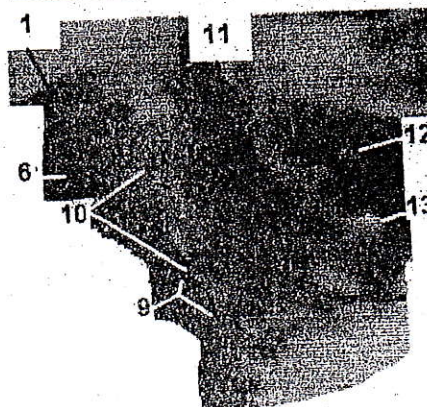
- The vertebral bodies separated by the cartilaginous discs.
- The transverse processes.
- Inter-vertebral synovial joints between the articular processes are seen at the lateral margins of the bodies, mainly at the thoracic region. But they are most obviously in oblique views.
- The pedicles show as oval outlines of cortical bone nearer the upper than the lower surfaces of the bodies, the spinous process are seen through the bodies.
- Presence of scoliosis.

In oblique and lateral XR-planes is easier to identify:

- The spinous processes.
- The inter-vertebral foramina, pedicles and synovial joints between the articular processes.
- Lordosis and Kyphosis.

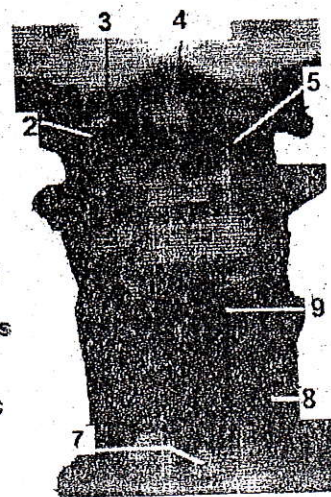
The most common XR-planes of the **chest** are postero-anterior and lateral views. We can identify scapulas, clavicles and **ribs** shadows, whose anterior ends (costal cartilages) are usually not visible and their bony parts appear overlapped forming a net. Hence, the intercostal spaces show a rhomboid-shape, through which is possible to see the lungs shadow. We can appreciate the semi-cone-shaped of the thorax cage and its apertures. It is no possible to precise the sternum outline because it is forming a common shadow with the thoracic column and the viscera (like heart, etc) which occupied the mediastinum.

CERVICAL VERTEBRAL COLUMN



Lateral view in flexed position

1. Posterior tubercle of Atlas (C-1)
2. Lateral mass (C-1)
3. Occipital condyle
4. Dens of Axis (C-2)
5. Lateral atlanto-axial joint
6. Spinous process of Axis (C-2)
7. Spinous process of C-7
8. Transverse process of C-6
9. Joint between articular processes
10. Intervertebral disc (C-5 & C-6)
11. Pharynx
12. Hyoid bone
13. Thyroid cartilage

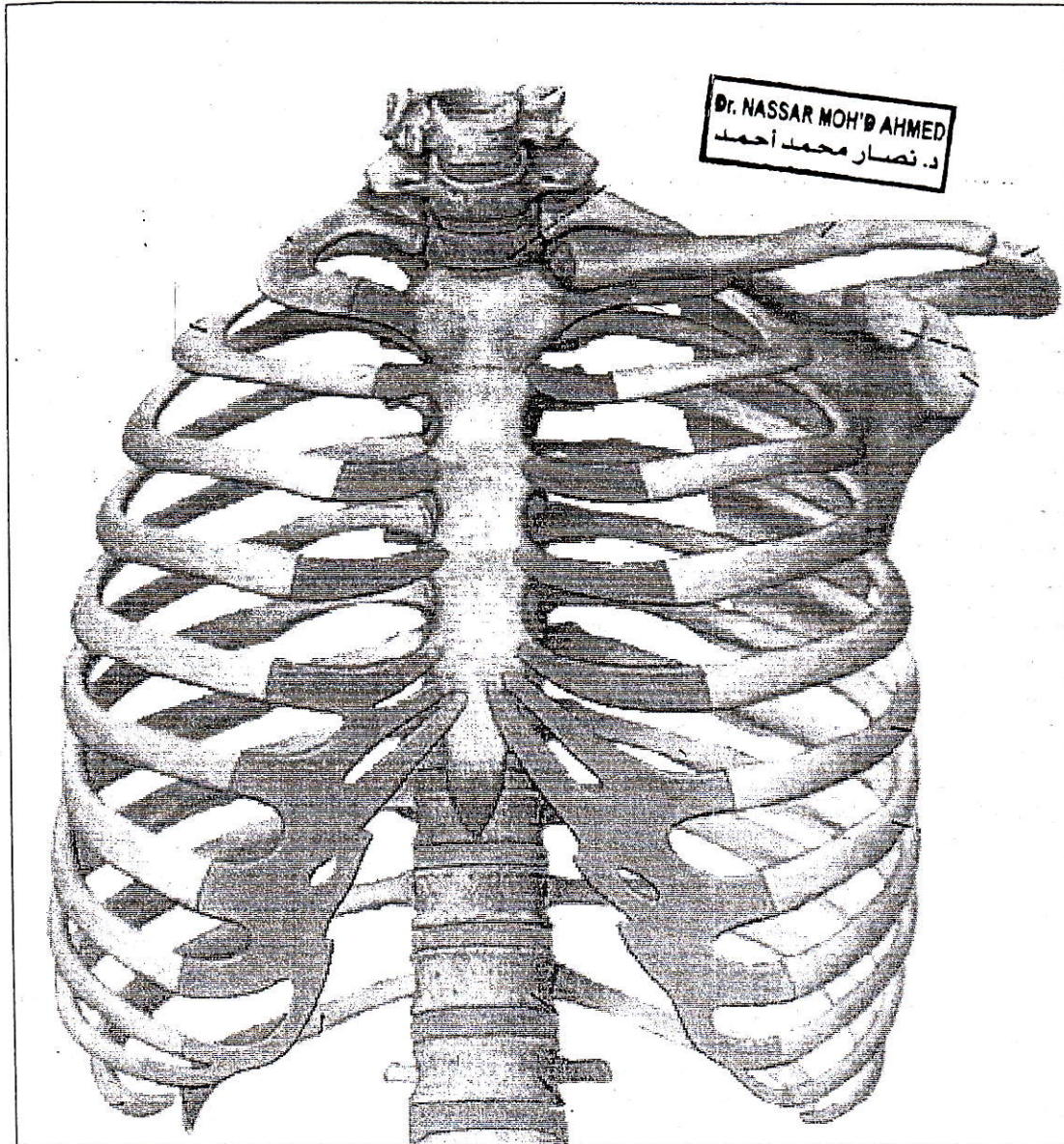


Antero-posterior view

UNIVERSITY OF ADEN. FACULTY OF MEDICINE AND HEALTH SCIENCES
DEPARTMENT OF MORPHOLOGICAL SCIENCES
HUMAN ANATOMY I FOR MEDICAL STUDENTS

SKELETON of the TRUNK

Part II: Thorax cage



(Lecture 4)

Foramin - 250
Canal - 250/31

THORACIC CAGE

The thoracic cage is the skeleton of the thorax. It is formed by

1. The twelve pairs of **ribs**, articulated at the front with
2. The **sternum** by
3. The **costal cartilages**, and at the back with
4. The **thoracic vertebrae** (by the synovial costo-vertebral and costo-transverse joints).

RIBS

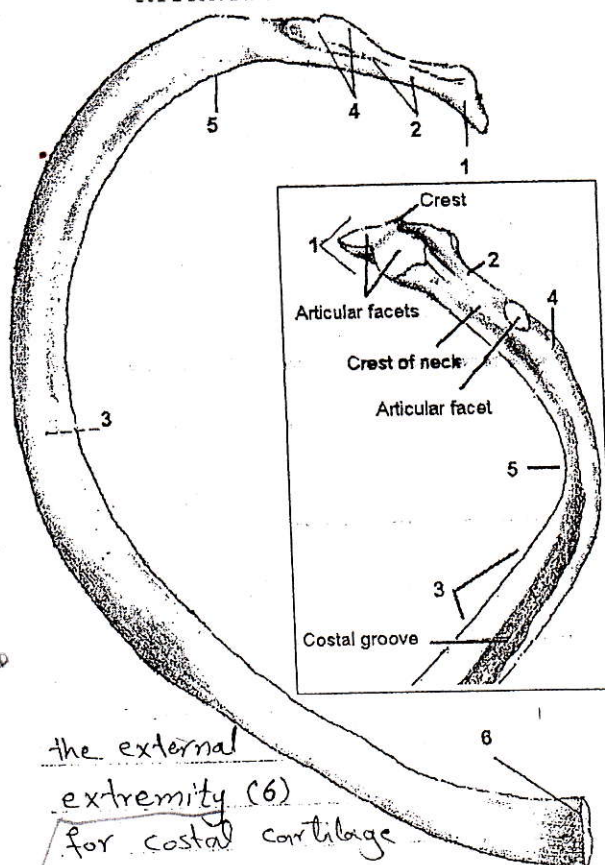
The ribs (costae) are twelve pairs -in both sexes- of flat, curved and slightly twisted/strip-like bones, extended obliquely on each side of the thorax between the thoracic vertebrae posteriorly and the costal cartilages anteriorly. A typical rib (from 3rd to 9th) has three main portions:

1. **Head**: two articular **facets**, separated by a **crest**, to join with two successive thoracic vertebrae (costo-vertebral joint). The crest attaches to the intervertebral disc through a ligament and its position is not always in the center because the proportion of the size of both facets varies.

2. **Neck**: a **tubercle** (4) with an articular facet to joint with the transverse process of thoracic vertebrae (costo-transverse joint).

3. **Body or shaft**: we may distinguish in it: external and internal surfaces, superior and inferior

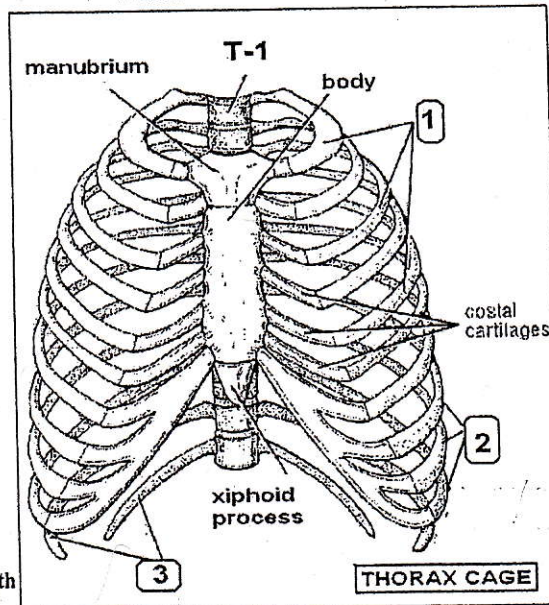
borders, costal angle (5), a costal groove to lodge the intercostals neuro-vascular bundle and



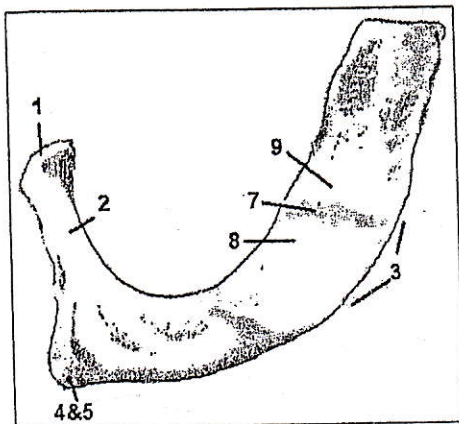
Classification of the ribs:

1. True ribs: the upper seven ribs, because their cartilages reach the sternum directly.
2. False ribs: eighth, ninth and tenth. Their cartilages articulate with the cartilage next above.
3. Floating ribs: eleventh and twelfth. Their cartilages lie

free within the muscular abdominal wall.



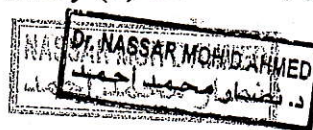
Atypical ribs: 1st, 2nd, 11th and 12th



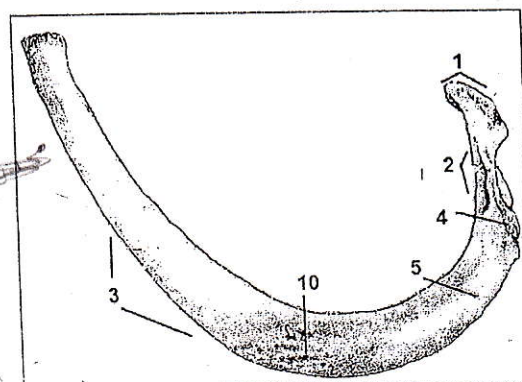
First rib: is short, flat, wide and sharply curved. It shows a single facet in the head (1), the tubercle at the costal angle (4&5), body with upper and lower surfaces and outer and inner borders. At the upper surface we find the scalenus tubercle (7) separating two subclavian grooves: for artery (8) and vein (9).

بروز مغیر خشن

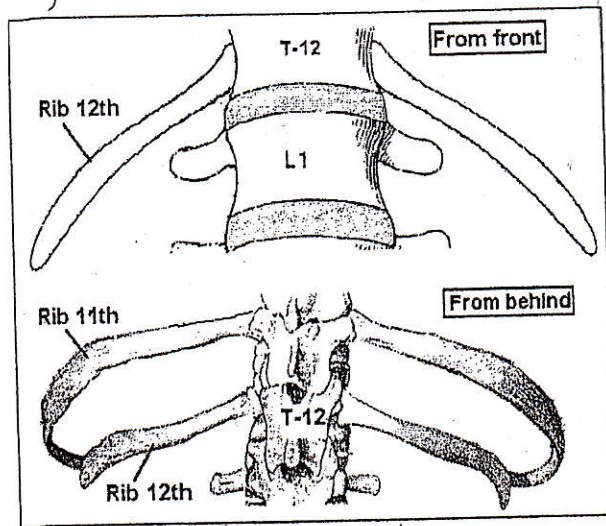
Horizontal



Second rib: is very much narrower and not twisted. It shows the tubercle (4) near the costal angle (5) and the body with oblique surfaces and borders. We find tuberosity (10) for serratus anterior muscle in the superolateral surface.



inferomedial surface



Eleventh rib: is short, narrow with a pointed sternal extremity. It shows a single facet in the head, small tubercle without articular facet and poorly defined angle and costal groove.

Twelfth rib: is similar to the 11th rib; but it does not show costal angle, tubercle and costal groove. It is the smallest-rib.

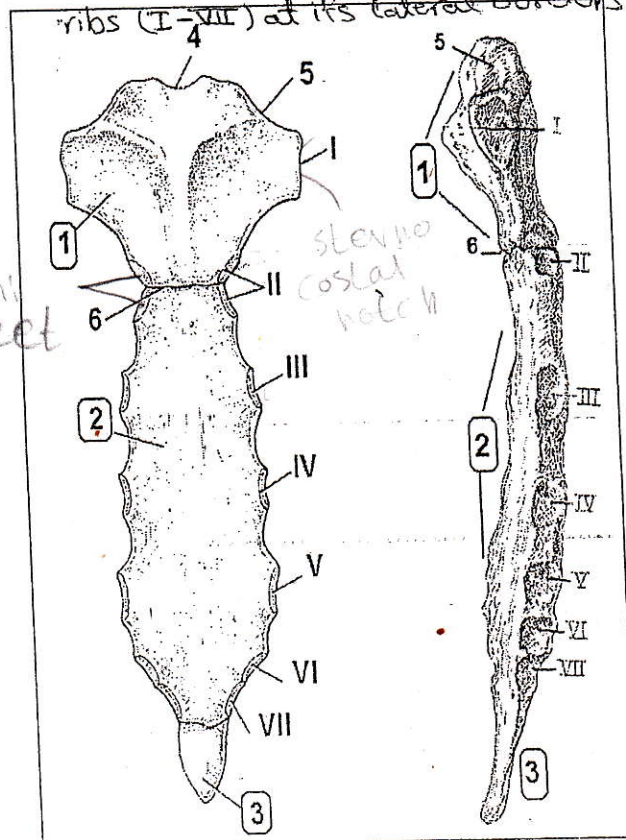
Dr. NASSAR MOH'D AHMED
د. نصار محمد أحمد

STERNUM

The sternum is a single, flat bone placed vertically at the anterior wall of the thorax, extended superficially from the root of the neck into the abdominal wall. It can be felt through the skin in its whole length. It is about 15-20 cm long, resembling a dagger with three main parts: 1. manubrium, 2. body and 3. xiphoid process, which are joined by cartilage.

The manubrium joins to the body by the fibro-cartilage of the manubrio-sternal joint, a symphysis. Two notches can be seen in this portion: **jugular** (4) and **clavicular** (5). Manubrium and body are angulated to each other: the **sternal angle** (6). The xiphoid process is an irregular piece that ossifies later in life.

The sternum articulates on each side with the clavicles at its upper end and with the costal cartilages belonging to the true ribs (I-VII) at its lateral borders.



Costal

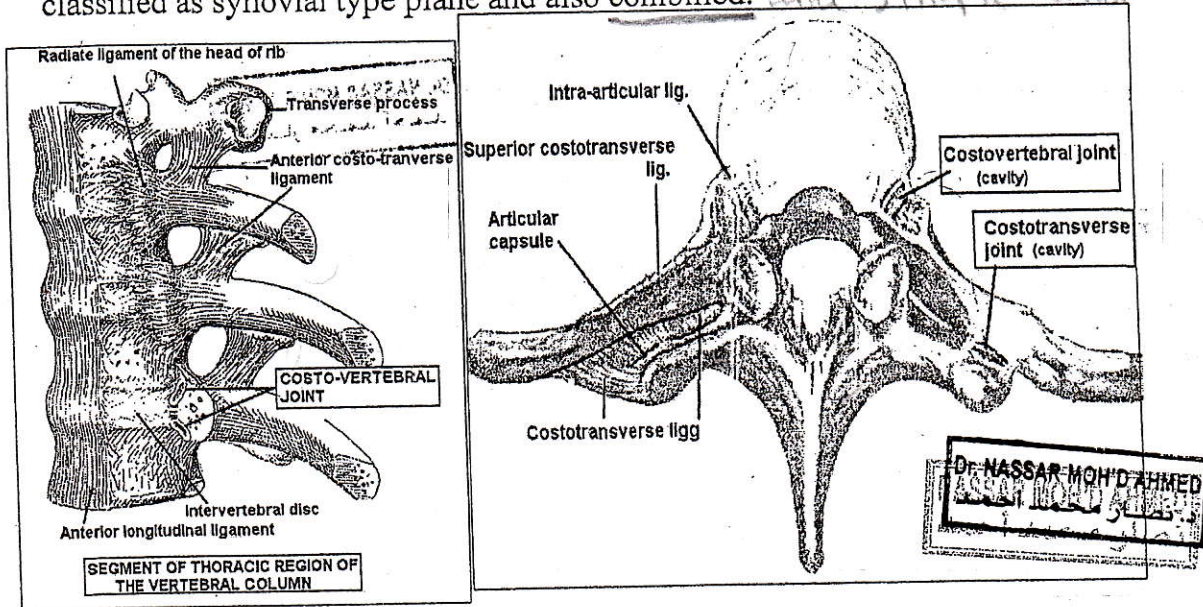
دار - زادی

JOINTS OF THE THORAX

1. **Costo-vertebral joints:** between the head of ribs and the articular semi-facets of the bodies of thoracic vertebrae. They are classified as synovial type plane and combined with the other side. We find here two ligaments: intra-articular and radiate ligament of the head of rib.

The first, tenth, eleventh and twelfth costo-vertebral joints are atypical: between single facets.

2. **Costo-transverse joints:** between corresponding articular facets of costal tubercle and transverse process of thoracic vertebrae. They are classified as synovial type plane and also combined. *and simple and nonaxial*



Both costo-vertebral and costo-transverse joints act as a combined trochoid joint which allow rotatory movements around the longitudinal axis passing along the neck of rib. Such rotational movements produce elevation and depression of ribs. Elevation of the ribs causes enlargement of the thoracic cavity, as occurs during inspiration, while depression of the ribs causes diminishing of the thoracic capacity, as occurs during expiration. (See pictures in following page)

3. **Esterno-costal joints:** between the sternum and the costal cartilages of the ribs. They are classified as follow:

- First: synchondrosis.
- Second to seven: synovial type plane. Here we can distinguish the anterior and posterior radiate ligaments. The intra-articular ligament is permanent

[costo-costal joint]

انterior radiate ligament -
 posterior radiate ligament -
 intra-articular ligament -

only in the second one: in the other joints disappear with the age because the cavities tend to obliterate.

4. Intercondral joints: between costal cartilages

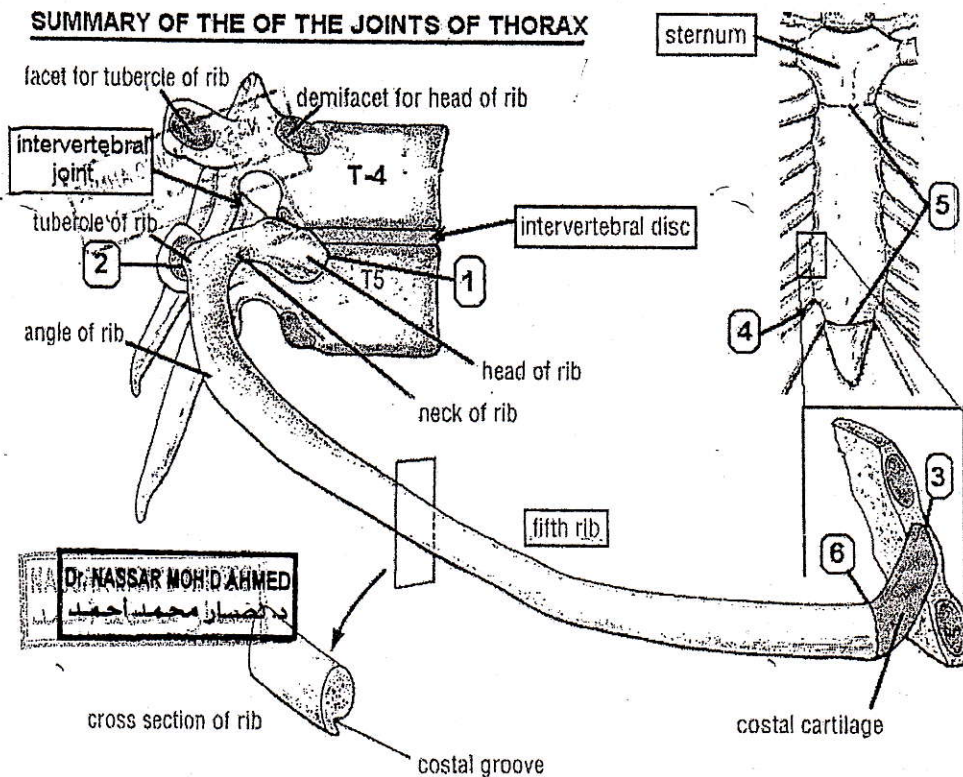
- Between adjacent margins of the 7th to 10th ribs → synovial.
- Between 11th to 12th ribs → syndesmosis.

5. Sternal joints: between parts of the sternum. They are symphysis.

- Manubrio-sternal.
- Xiphosternal joint.

6. Costocondral: some authors use this name for the junction between the two parts of the ribs, the costal bone and the costal cartilage.

SUMMARY OF THE OF THE JOINTS OF THORAX

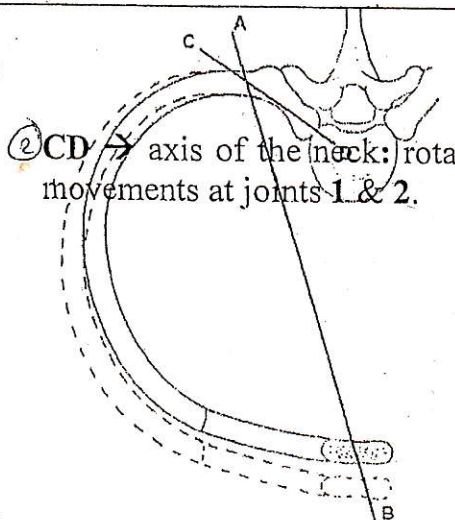


Movements of the thorax (diagram)

--- line: inspiration
 — line: expiration

① AB → vertebro-sternal or vertebro-condral axis of rotation of the rib.

② CD → axis of the neck: rotatory movements at joints 1 & 2.



THE THORAX AS A WHOLE

Functions:

1. **Protection** of the thoracic viscera and vessels.
2. **Support** against the elastic pull of the lungs (otherwise they would collapse)
3. **Suction** apparatus to allow air enters the lungs.
4. **Movements** of respiration.

The thoracic cage has conical shape, with its apex and base cut off obliquely. It is distinguished two **apertures** and four **walls**:

Superior aperture (inlet or apex): at the root of the neck. Open freely to the neck, oblique forwards and downwards. It is about 5cm antero-posteriorly and 10 cm transversely. Its boundaries are:

- Anteriorly → manubrium sterni
- Posteriorly → first thoracic vertebra
- Laterally → first ribs and costal cartilages.

Inferior aperture (base): large, closed by the diaphragm.

Boundaries:

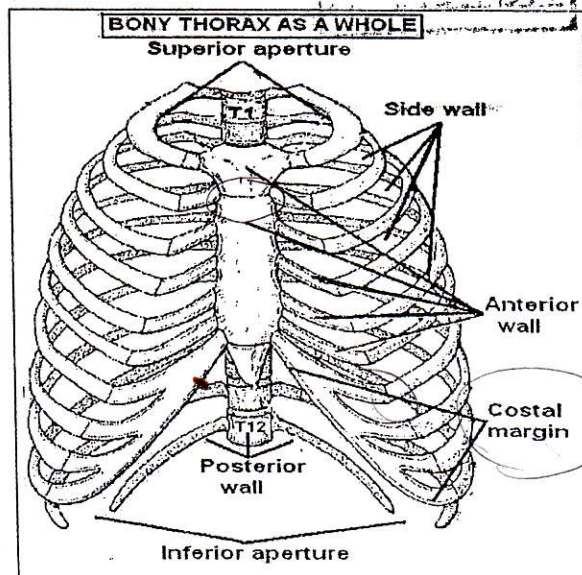
- Anteriorly → xiphosternal joints and the 7th to 10th costal cartilages which form the infra-sternal angle and costal margin.
- Posteriorly → twelfth thoracic vertebra.
- Laterally → 11th and 12th ribs.

The lower costal cartilages joined to each other form the **costal margin**.

The posterior wall of the thoracic cage is formed by the thoracic section of the vertebral column and the posterior parts of the ribs forming two para-vertebral grooves called **pulmonary sulcus**.

The side-walls (lateral walls) are formed by the bodies or shafts of the ribs, separated by the **intercostals spaces**.

The anterior wall is shorter than the others because it is formed only by the sternum and part of the costal cartilage.



SURFACE ANATOMY OF THE TRUNK SKELETON

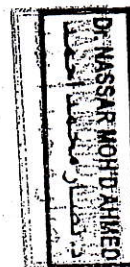
Median furrow of the **back** varies in depth with the irregularities of the body. It is deepest in the upper part of the loin. Passing the finger through it we can feel the spinous processes of the vertebrae. First spinous process felt at the back of lower part of the flexed neck is belonging to the vertebra prominens (7th VC). Thoracic vertebrae are counted downwards from this spine.

Relationship of vertebral spines with other landmarks (in adult age)

SPINE	LEVEL
2 ND Cervical	It is the uppermost spine felt in the back of the neck.
7 th Cervical	It is the upper of the two prominences seen at the root of the back of the neck.
1 st Thoracic	It is the lower of the two prominences seen at the root of the back of the neck.
3 rd Thoracic	A point where the crest of spine and medial border of scapula meet.
7 th Thoracic	It lies opposite the inferior angle of the scapula.
12 th Thoracic	It lies opposite the midway between inferior angle of the scapula and the level of upper border of the iliac crest.
4 th Lumbar	At the level of the highest part of iliac crest.
3 rd Sacral	It lies at the upper end of the gluteal cleft.

In the front of the thorax the following landmarks are palpable:

1. The **jugular or suprasternal notch**: at the upper border of the manubrium sterni, between the clavicles. It is at the level with the lower border of the 2nd VT. The **manubrium** lies between this notch and the sternal angle.
2. The **sternal angle** is felt as a transverse ridge about 5cm below the jugular notch. It is at the level with the disc between the 4th & 5th VT. It is a very important landmark because allows us to count the ribs and intercostal spaces since the 2nd costal cartilage articulates with the sternum at this site.
3. **Costal margin** is formed by the costal cartilage of the 7th to 10th ribs.



- 9
4. **Infrasternal or subcostal angle** is formed at the meeting place of the two costal margins. The **xiphoid process** lies in its depression and the **joint** between it and the sternal body may be felt as a small transverse ridge at the apex of the infrasternal angle. The sternal **body** can be palpated between the xiphosternal joint and the angle.
 5. It is very easy to recognize the **clavicle** and the **sternoclavicular joint** can be felt at the medial end of it, when the arm is abducted above the head. The **1st costal cartilage** lies below the medial end of clavicle.



Ribs can be counted:

Anteriorly → count downwards from the 2nd costal cartilage.

Posteriorly → the 8th rib lies just below the inferior angle of the scapula.

RADIOLOGICAL ANATOMY OF TRUNK SKELETON

The **vertebral column** can be studied taking antero-posterior, lateral and oblique radiograph. It is very important to take into account the age of the patient to interpret them properly. They are more frequently performed at the cervical and lumbar regions.

In an antero-posterior XR-plane is possible to identify:

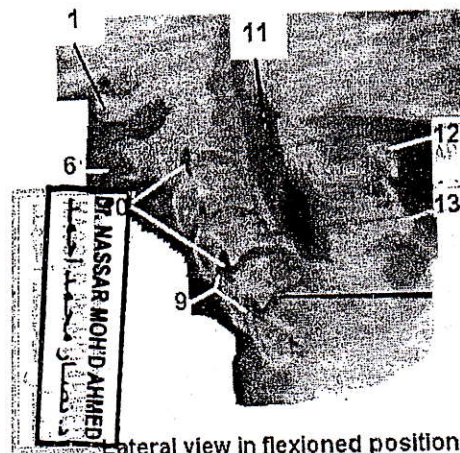
- The vertebral bodies separated by the cartilaginous discs.
- The transverse processes.
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- The pedicles show as oval outlines of cortical bone nearer the upper than the lower surfaces of the bodies, the spinous process are seen through the bodies.
- Presence of scoliosis.

In oblique and lateral XR-planes is easier to identify:

- The spinous processes.
- The inter-vertebral foramina, pedicles and synovial joints between the articular processes.
- Lordosis and Kyphosis. The most common XR-planes of the **chest** are postero-anterior and lateral views. We can identify scapulas, clavicles and **ribs** shadows, whose anterior ends (costal cartilages) are

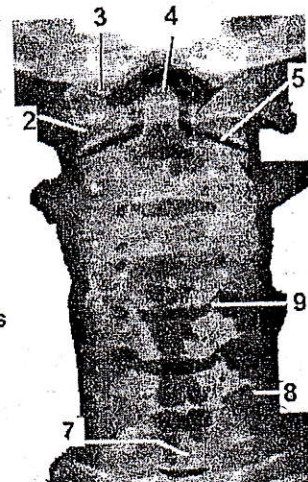
usually not visible and their bony parts appear overlapped forming a net. Hence, the intercostal spaces show a rhomboid-shape, through which is possible to see the lungs shadow. We can appreciate the semi-cone-shaped of the thorax cage and its apertures. It is no possible to precise the sternum outline because it is forming a common shadow with the thoracic column and the viscera (like heart, etc) which occupied the mediastinum.

CERVICAL VERTEBRAL COLUMN



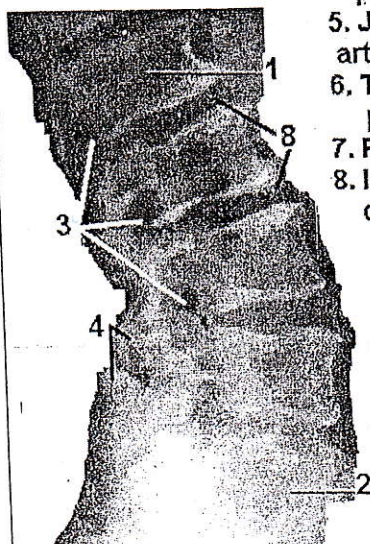
Lateral view in flexioned position

1. Posterior tubercle of Atlas (C-1)
2. Lateral mass (C-1)
3. Occipital condyle
4. Dens of Axis (C-2)
5. Lateral atlanto-axial joint
6. Spinous process of Axis (C-2)
7. Spinous process of C-7
8. Transverse process of C-6
9. Joint between articular processes
10. Intervertebral disc (C-5 & C-6)
11. Pharynx
12. Hyoid bone
13. Thyroid cartilage



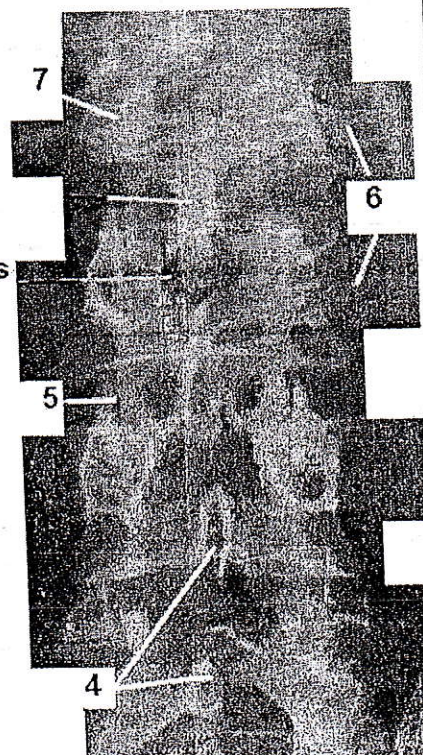
Antero-posterior view

LUMBAR VERTEBRAL COLUMN



Lateral view

1. Body of L-1
2. Body of L-5
3. Intervertebral foramen
4. Spinous processes
5. Joint between articular processes
6. Transverse processes L-2,3
7. Pedicle of L-2
8. Intervertebral discs (L1-L2-L3)



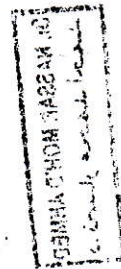
Antero-posterior view

GUIDE FOR PRACTICAL CLASS # 3

Theme: Skeleton of the trunk (Second Part): BONY THORAX

Summary: Bones and joints of the bony thorax.

1. Bony thorax (thorax cage): components.
2. Sternum: situation, parts, features.
3. Ribs: features of typical and atypical ribs.
Classification of ribs.
4. Joints of the thoracic cage and movements.
 - a. Between ribs and sternum.
 - b. Between ribs and vertebrae.
 - c. Between vertebrae.
5. Thorax as a whole.



Objectives:

1. To describe a typical rib identifying its portions and details.
2. To identify and describe briefly the particular characteristics of some ribs: 1st, 2nd, 12th, etc
3. To identify the sternum and describe it.
4. To identify and classify the joints of the thorax cage as well as explain the movements provided for these joints.
5. To identify the anatomical details through the surface of the body and in radiographs (simple XR-plains).

Methodological orientation (TASKS):

1. Identify and describe the **sternum** (fig. 48-49) attending to: classification, situation in the body and anatomical position, portions, surfaces, borders and osseous details.
2. **Ribs:** in the same way, identify and describe:
 - Any typical rib and indicate its general characteristics (fig. 46).
 - Any atypical rib (or exceptional) like the 1st, 2nd and 12th. They show particular characteristics, mainly in the ends.
 - Classify the ribs according to their joints to the sternum.

3. Indicate in the skeleton the **joints of the thorax cage**, mentioning the names and classifications.

In order to organize these, you may use the following:

- Joints between the ribs and the sternum (sterno-costal).
- Joints between the ribs and the vertebral column (vertebral body & costal head) and costo-transversal (transversal process & costal tubercle).
- Joints between vertebrae (you know them from the previous class)



4. Practice the movements of the thorax and mention its names.

5. **Surface and radiological anatomy of the thorax cage.**

- On the chest (thorax wall) palpate: portions of the sternum, jugular notch and sternal angle. Find out the costal margin (formed by the costal cartilages of the 7th to 10th ribs) and infrasternal or subcostal angle (at the meeting place of the two costal margins). Palpate the first costal cartilage below the medial end of the clavicle, the second cartilage at the level of sternal angle and count the ribs downwards.
- In any radiological view of the chest identify ribs and intercostals spaces. Notice the rib angles and the inclination of the costal bones (costal cartilages are not usually visible).

6. Do not forget to study the features of the human thorax cage as a whole.

Bibliography:

- Cunniggham's textbook of Anatomy. 12th edition. Pages 103 to 106 and 226 to 228.
- Sobotta/figge. Atlas of Human Anatomy. Vol 1. Page 94-103.
- You can use Practical Anatomy I' booklet. Pages 4 to 10.

SKULL:

SKELETON of the HEAD

Part I: Individual bones

Bones of neurocranium



Single:

- **FRONTAL**
- **OCCIPITAL**
- **ETHMOID**
- **SPHENOID**

Paired:

- **TEMPORAL**
- **PARIETAL**

Bones of viscerocranium



Single:

- **VOMER**
- **MANDIBLE**
- **HYOID**

Paired:

- **MAXILLA**
- **PALATINE**
- **NASAL**
- **LACRIMAL**
- **ZYGOMATIC**
- **INFERIOR NASAL CONCHA**

SKELETON OF THE HEAD: SKULL

PART I:

- General characteristics. Division. Portions.
- Independent bones of the skull: anatomical situation, joints, portions and main anatomical features.

The skull (cranium) is defined as the skeleton of the head. It belongs to the axial part and constitutes a bony framework which lodges the brain, sense organs, and the initial portions of the alimentary canal and respiratory passages.

The skull is customarily divided into two portions:



1. **Neurocranium:** the largest postero-superior part enclosing the brain (organs of the Central Nervous System). It is subdivided into:

- Calvaria or vault: top part or skull-cap.
- Base: inferior part (seen from below or after removing the calvaria and the encephalon)

2. **Viscerocranium:** the smaller antero-inferior portion forming the framework of the face and a number of cavities (orbitals, nasal cavity, oral cavity, ear) which encloses the sense organs (eye-ball, middle and inner ear-organs of hearing and balance, olfactory nerve endings, taste buds of the tongue) and initial portions of the alimentary canal (mouth) and the respiratory passages (nasal cavity). It is composed by a number of bones which derived embriologically from the branchial (visceral) arches, hence its name 'viscerocranium'.

Most facial bones and also those of the neurocranium are firmly joined to one another by non-mobile joints (sutures and synchondroses) forming a rigid case, **cranial cavity**, and other cavities. But two of them are mobile: **the mandible** which articulates to the temporal bone by a synovial joint (temporo-mandibular joint), and **the hyoid bone** at the root of the tongue whose position is maintained by muscles and ligaments.

3

Process: ~~long bone~~ öst. 20cm
spine: 20cm

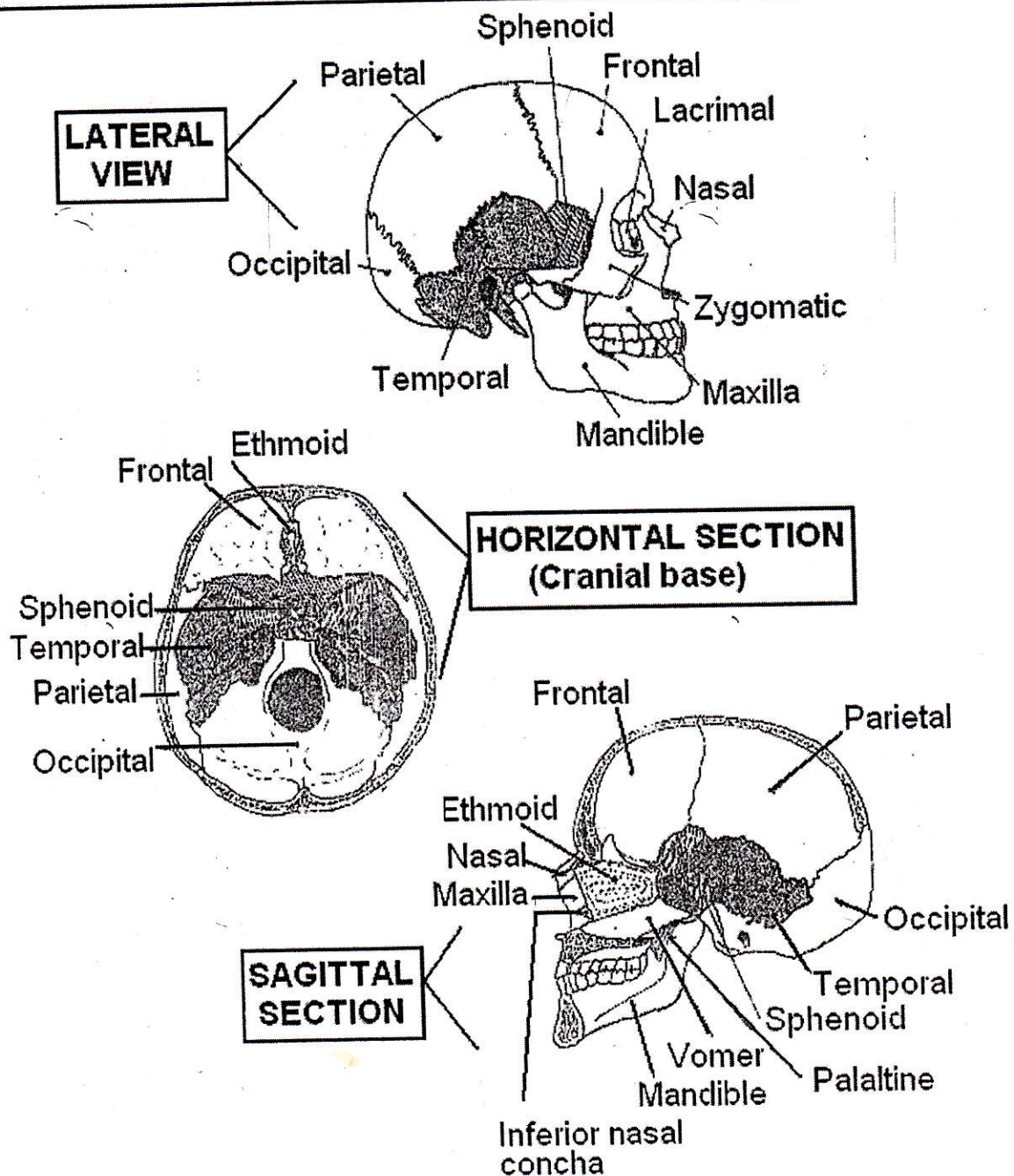
Total: 8

Total: 15

The skull comprises 23 bones (auditory ossicles and sutural bones are not included).

Dr. NASSAR MOH'D AHMED
د. نصار محمد احمد

Diagrams to show the anatomical situation of the bones in the skull



DESCRIPTION OF THE INDEPENDENT BONES

FRONTAL BONE

It is a single (unpaired) **pneumatic** bone since contains the frontal sinus. It contributes to the forehead, nasal cavity, anterior wall of the calvaria and cranial cavity (anterior cranial fossa), orbits, and temporal fossa. Also includes a pneumatic chamber called **frontal sinus**.

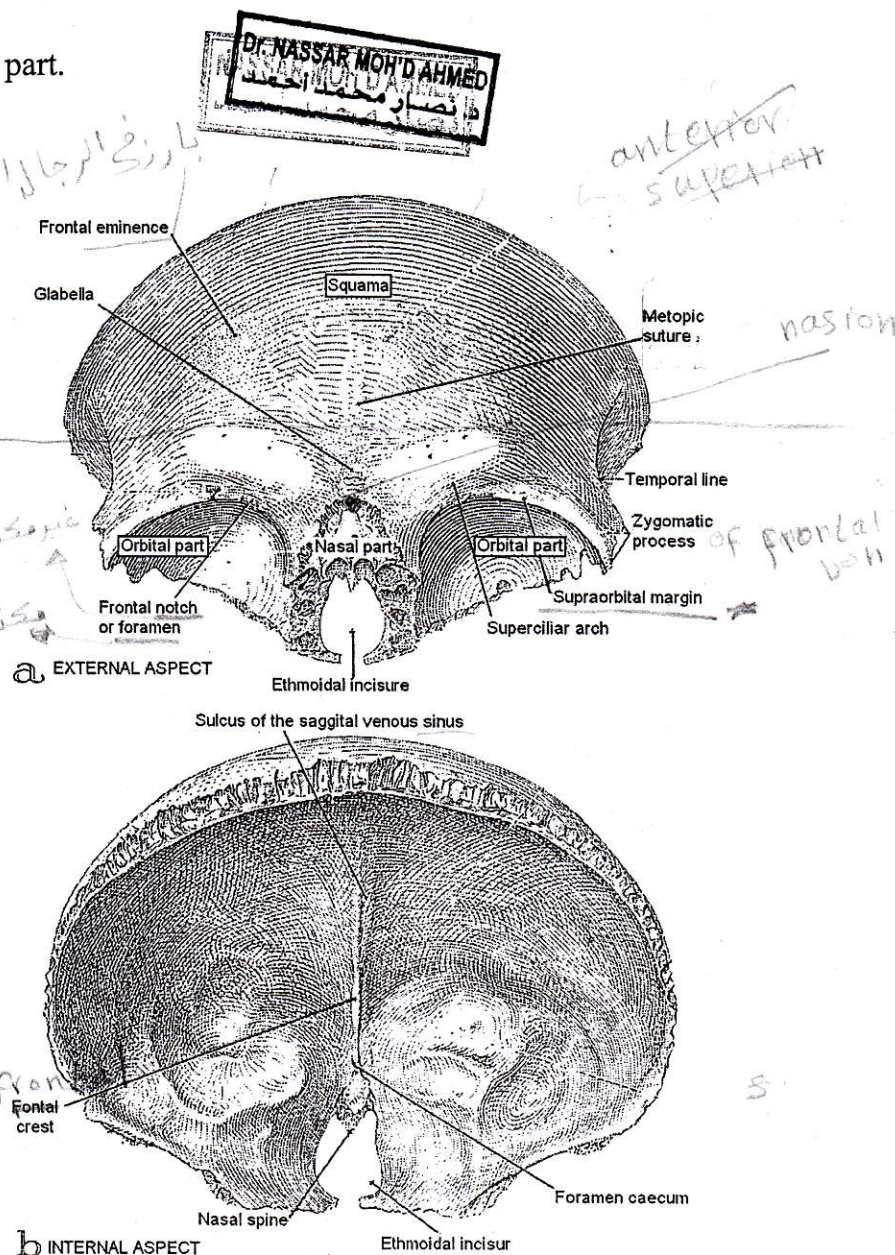
Situation: at the anterior and superior portion of the skull.

Parts:

- Squama or squamous part.
- Nasal part.
- Orbital part or plates.

Main anatomical details:

They should be organized attending to the surfaces (*anterior, temporal, orbital and cerebral*) we can see from different aspects. The most relevant details are in the external aspect: glabella, eminences, superciliary arches, supraorbital borders and foramens, temporal lines, etc. The ethmoidal incisure is observed if the bone is seen from below: it is situated behind the nasal part and between both orbital parts. The zygomatic processes are laterally to the orbital parts. Each segment of the peripheral borders receives the name according the bone is joined (suture) to it.



ETHMOID BONE

It is a single (unpaired) bone. It is classified as **pneumatic** due to the presence of several small cavities (**ethmoidal air cells**) located at the two **lateral parts or labyrinths**. They are arranged into three groups: **anterior, middle and posterior ethmoidal air cells**.

Situation: this bone is placed centrally between the bones of the face, forming most of the walls of the nasal cavity, a part of the medial wall of orbit and the central portion of the anterior cranial fossa. Observe that one part of it is filling the ethmoidal incisure of frontal bone.

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د. نصار محمد أحمد

Parts:

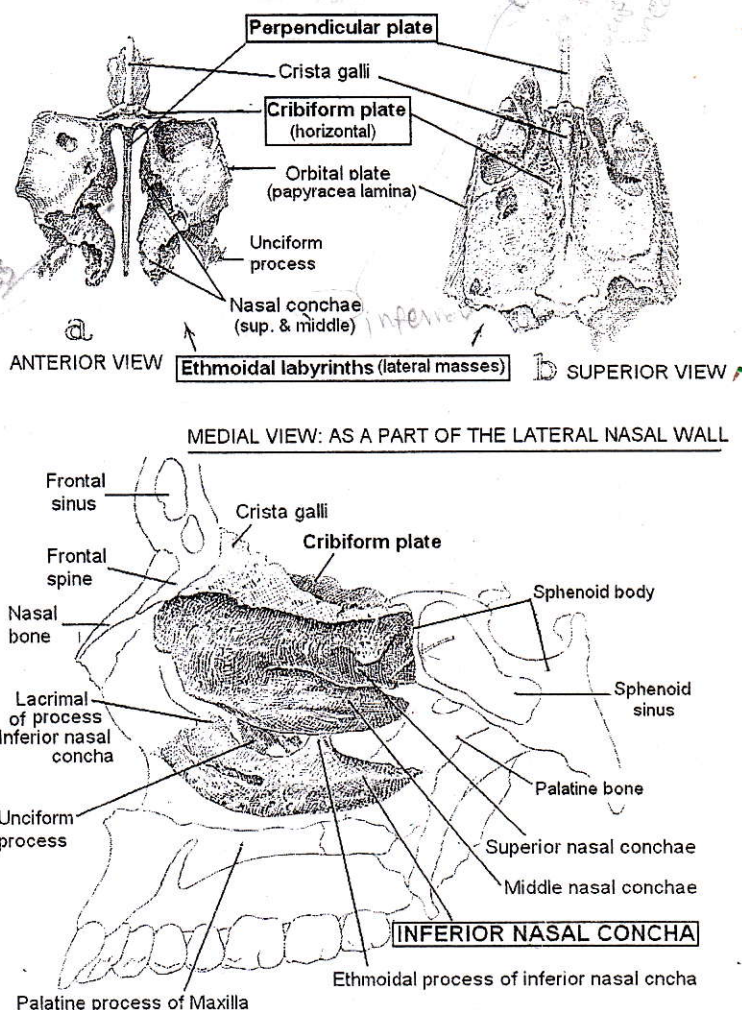
- Perpendicular plate → is a vertical lamina which forms the major part of the nasal septum.
- Cribriform or horizontal plate → passage of olfactory nerves.
- Ethmoidal labyrinths or lateral masses → contain the ethmoidal air cells and form the lateral walls of nasal cavity.

Main anatomical details:

- **Crista galli:** like a cock-crest it is a small part of the perpendicular plate above the cribriform plate.

- **Nasal conchae:** are curved plates towards the nasal cavity

- **Orbital plate:** is the lateral part of the labyrinths, which is forming the medial wall of the orbit.



OCCIPITAL BONE

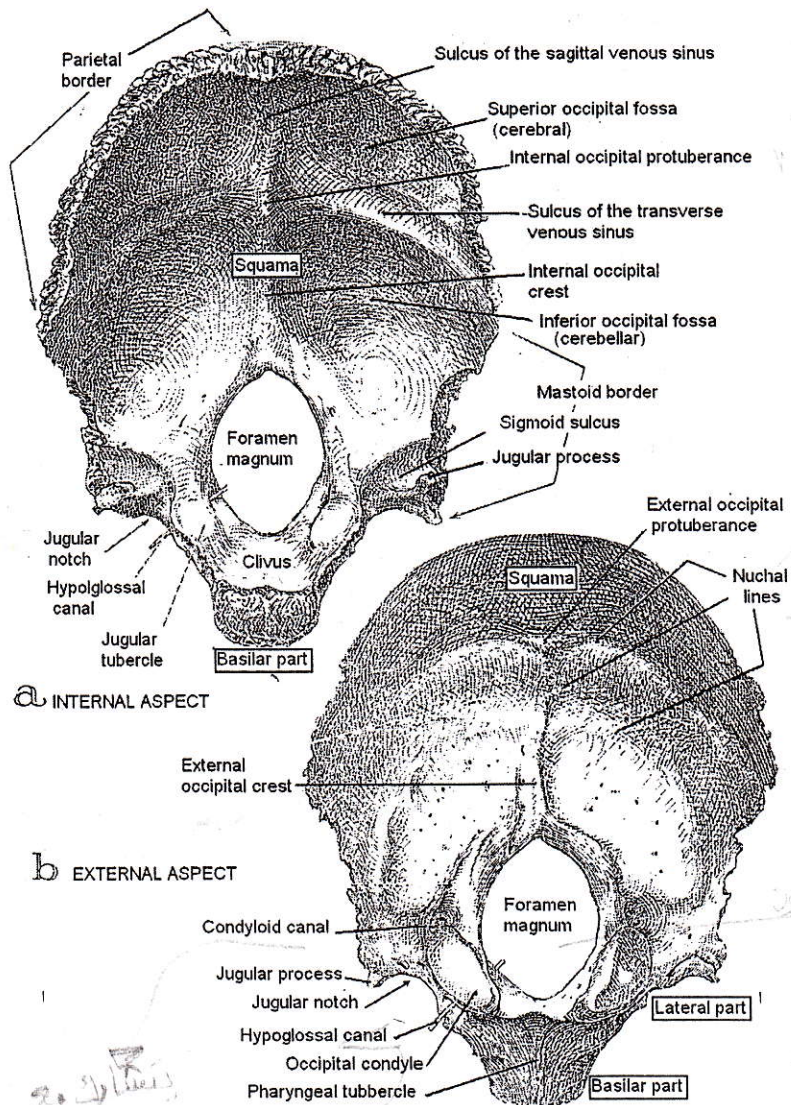
It is a single (unpaired) **irregular** bone, which contributes to form the posterior portions of the calvaria, the cranial cavity and the base. It is **situated** at the postero-inferiorly in the neurocranium, showing the important communication of the vertebral canal and the cranial cavity, the **foramen magnum**, around which converges the four **parts**:

- Squama or squamous part.
- Lateral or condylar parts (2).
- Basilar part.

Main anatomical details:

They are described attending to the surfaces (external and internal) although some of them, like *foramen magnum*, *jugular process* and *jugular notch* can be observed in any way. Externally, the more remarkable details are the central *protuberance*, from where arises the *crest* downwards and perpendicularly we can distinguish the nuchal lines. The *occipital condyles* articulate with the superior articular surfaces of the atlas (see previous theme), and in its base we can find out the *hypoglossal canal*. Internally, also we can see a *protuberance* in the center of a cruciform eminence, which divide the inner surface of the squama into four *fosse*. The *clivus* is a depression to lodge the brain stem.

Dr. NASSAR MOH'D AHMED
نصار محمد احمد



SPHENOID BONE

It is a single (unpaired) bone. It is classified as **pneumatic** because there is an air chamber, the *sphenoidal sinus*, within the body.

Its **shape** is very irregular and complicated, resembling a bat or a wasp with their wings extended. It contributes to almost all cavities and fossae of the skull with the only exception of the oral cavity.

Situation: at the central portion of the cranial base, joining with many bones. Because of this feature, some authors consider it as 'the key' of the skull-base. *behind orbital cavity*

Parts (according to the described shape):

- Body: is the central, cuboid part from which the other ones arise.
- Greater wings.
- Lesser wings.
- Pterygoid processes.



Main anatomical details:

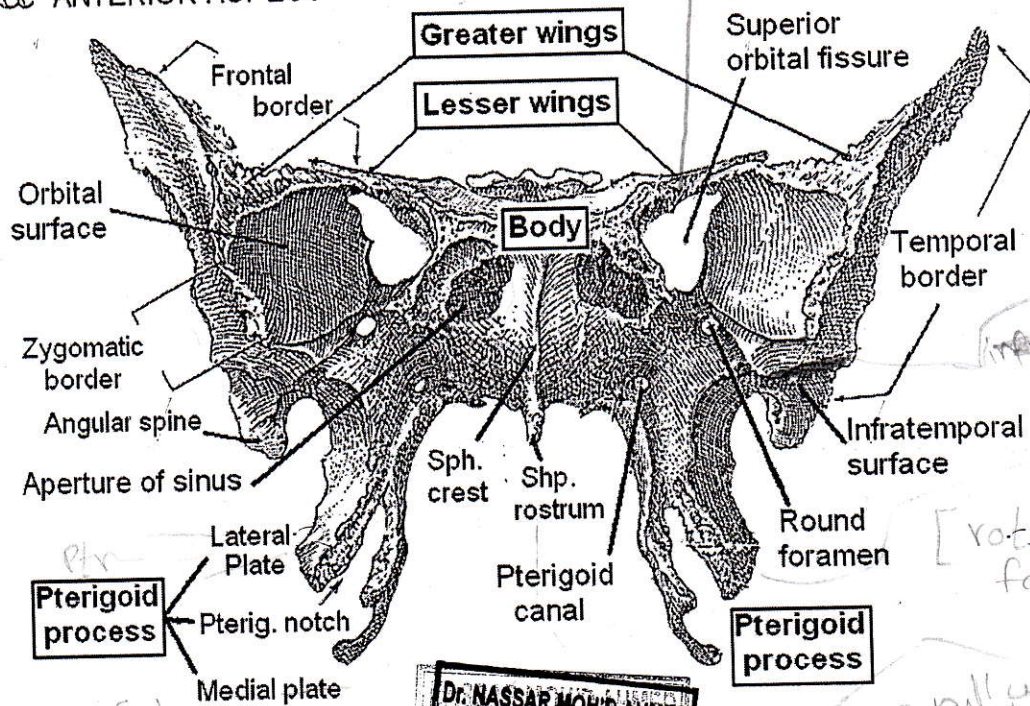
In the body: superiorly we can see the '*sella turcica*' with the pituitary fossa to lodge the corresponding gland, the dorsum sellae behind, the *chiasmatic groove* and *sphenoidal jugum* forwards and four *clinoid processes* in the angles. Laterally: the carotid sulcus. In front: the *sphenoidal crest* ends downwards in the *rostrum* and both side are the *apertures* of the sphenoidal sinuses.

At both sides of the body, there are three foramina piercing the root of the greater wings: *round*, *oval* and *spinous foramen*. The greater wings show many surfaces -*temporal*, *infratemporal*, *orbital* and *cerebral*- and the corresponding margins or crests bounding them. The wings are separated each other by the *superior orbital fissure*. The lesser wings show only two surfaces: *orbital* & *cerebral*; their roots are united by the *sphenoidal jugum* and we can see the *optic canal* traversing below the origin..

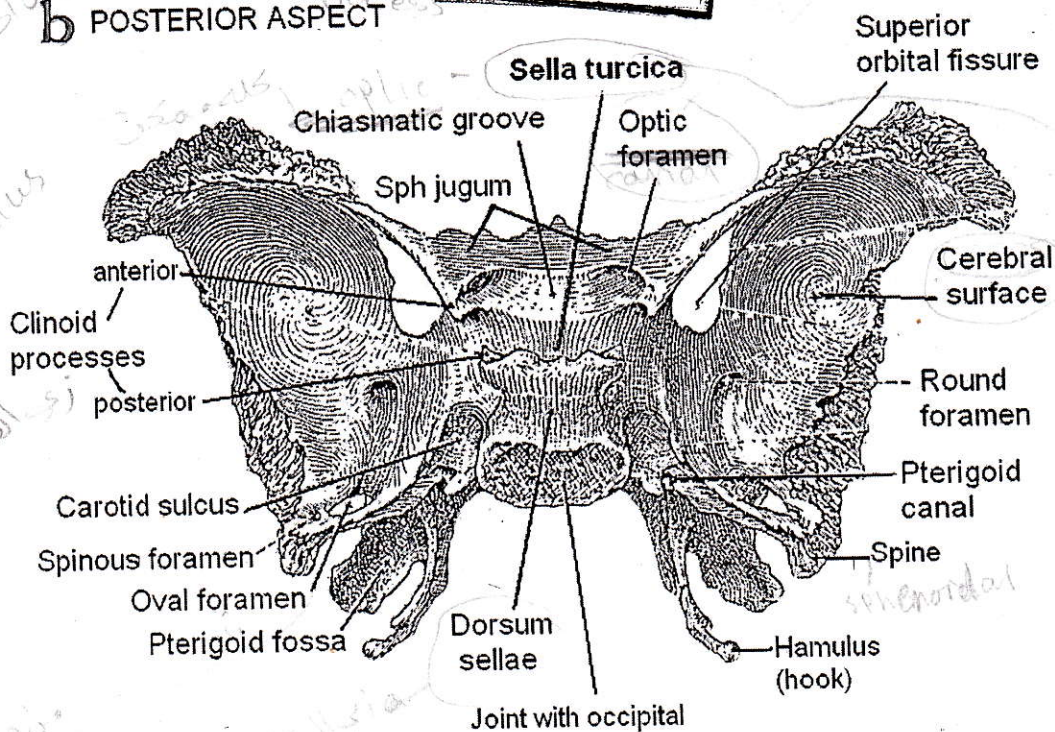
The pterygoid processes are formed by two plates -*lateral* & *medial*- separated by a *notch* inferiorly and by a *fossa* posteriorly. The medial plate is narrower, longer and ends into a hook. Two narrow antero-posterior communications are passing through the root of the process in: the *pterygoid* and *pharyngeal canals*.

Many other small anatomical details can be described in this bone.

a ANTERIOR ASPECT



b POSTERIOR ASPECT



Dr. NASSAR MOHID AHMED
د. نصار محمد أحمد

TEMPORAL BONE

It is a paired bone, classified as **pneumatic** because it includes several small air cavities at the mastoid process (**mastoid air cells**), which communicate to the middle ear (tympanic cavity). The temporal bone also encloses the organs of hearing and balance and has many grooves and canals to allow passing through some blood vessels-like internal carotid artery- and some nerves, e.g.: vestibulo-cochlear and facial. That's why it shows a very complicated anatomy.

Situation: the temporal are situated at both sides of middle part of the cranial base and infero-lateral part of the calvaria.

Parts:

- Squamous part.
- Petro-mastoid portion. It should be subdivided into two parts: one internal, the *petrous part or pyramid* and the other external, the *mastoid part*.
- Tympanic part.



Main anatomical details:

They should be studied attending to the portions and the different views. But here only will be mentioned the most relevant details according to the type, which permit you to place the bone in the proper anatomical position.

In the squama is very easy to distinguish the *temporal* (external) *surface* from the *cerebral* (internal) one. The *borders* receive the name of the bone which is joining to.

Processes:

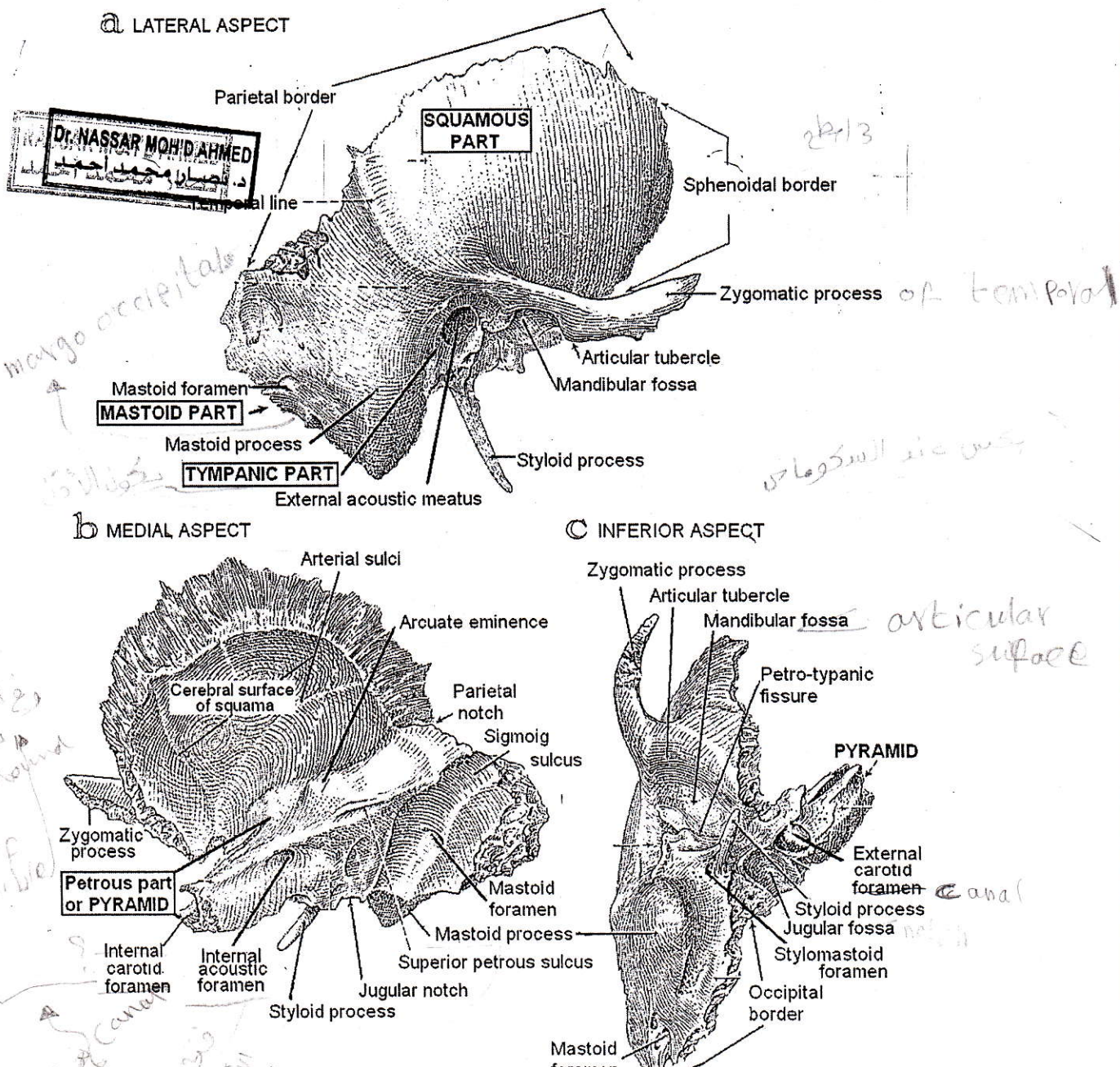
- *Zygomatic*: forwards, to form the corresponding arch.
- *Mastoid*: backwards, it is rounded and can be palpated behind the auricle.
- *Styloid*: downwards, it is long, thin and pointed.
- There are many other small spines, smooth lines, crests, eminences, etc. It is important the *articular tubercle* because takes part in a synovial joint.

Foramens:

- There are two acoustic canals, so that we can distinguish the *external* and *internal acoustic pores*.
- The *carotid canal* also has two foramina: *external* and *internal*.
- Besides, there are other smaller like *mastoid* and *stylomastoid foramina*.

Depressions:

- There are described a lot of notches (incisures) and grooves (sulci), which receive the name attending to the structure is filling each of them in living people. E.g. the *parietal notch* is occupied by a parietal angle; the sigmoid venous sinus runs along the *sigmoid sulcus*, etc.
- Especially relevant are the *jugular* and the *articular fossae*



PARIETAL BONES

It is a paired bone, typical example of a **flat bone**.

Shape: They are simple quadrilateral, curved plates of bone with typical diploic structure.

Situation: The two parietal bones are located at the superior and lateral sides of the calvaria and cranial cavity.

The parietal bones are described as having **four borders or margins**, and **four angles**. They are named according to their location and/or the sutures with related bones.

Anatomical details:

We can observe only a few of them because this is a very simple bone.

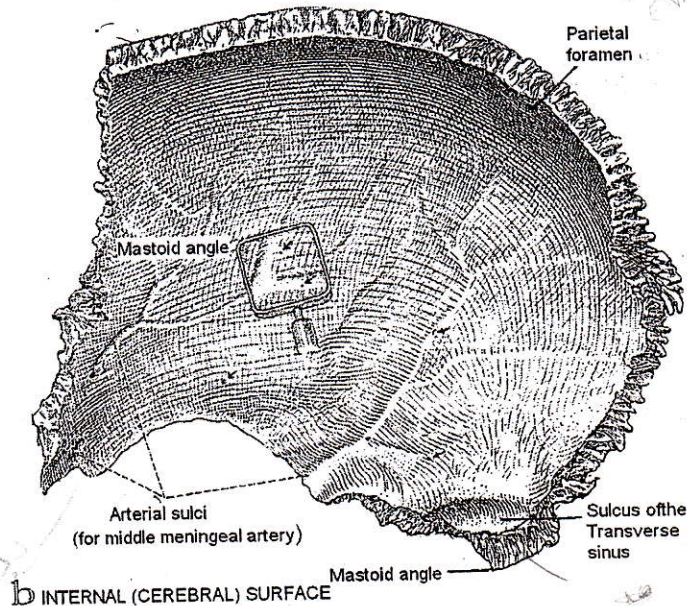
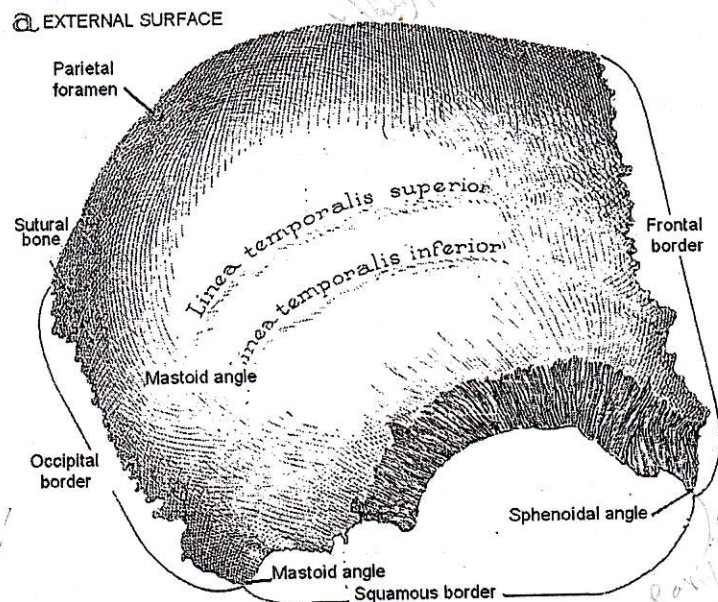
- Parietal foramen
- Temporal lines
- Vascular sulcus

Borders

1. Anterior or coronal.
2. Posterior or lamboid.
3. Superior or sagittal
4. Inferior or squamous

Angles

1. Frontal (antero-superior)
2. Sphenoidal (antero-inferior)
3. Occipital (postero-superior)
4. Mastoid (postero-inferior)



MANDIBLE

It is a single and **irregular** bone.

Situation: it forms the skeleton of the lower part of the face and articulates to the temporal bone by the synovial temporo-mandibular joint.

Parts:

- A **body** (horseshoe-shaped portion) joined to
- A pair of **rami** at a region called **angle of the mandible**.

The upper border of the body is **the alveolar process** carrying the **alveoli** for the lower teeth. The upper end of each ramus presents **the condylar process** to join with the temporal bone.

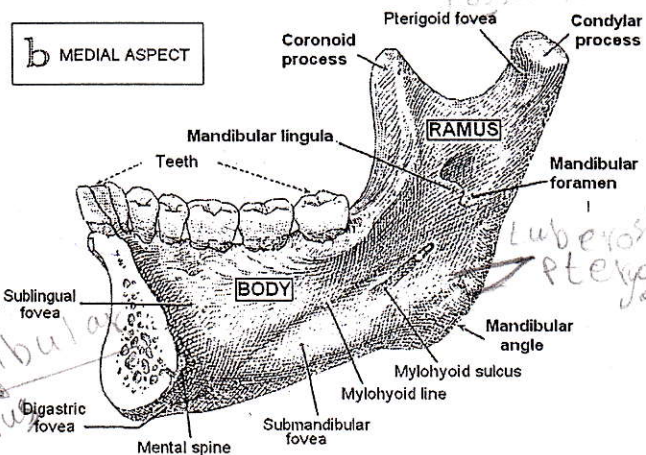
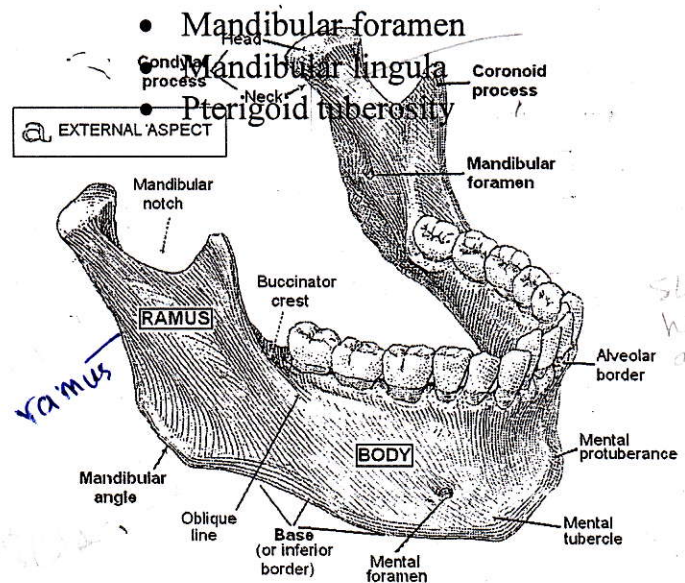
Main anatomical details:

Body: we can see

1. Superior border: alveolar arch
2. Inferior border or base
 - **Angle of mandible**
3. In the outer surface:
 - Mental protuberance
 - Mental tubercle
 - Mental foramen
 - Oblique line
 - Masseter-tuberosity
4. In the inner surface :
 - Mental spine
 - Digastric fovea
 - Mylohyoid line & sulcus
 - Sublingual fovea
 - Submandibular fovea

Ramus: it shows two vertical processes: **condylar & coronoid** separated by the **mandibular notch**. And medially:

Mandibular foramen
Mandibular lingula
Pterigoid tuberosity



MAXILLA

It is a paired and **pneumatic** bone.

Situation: on each side of the midline at the centre of the facial skeleton forming the 'upper jaw'.



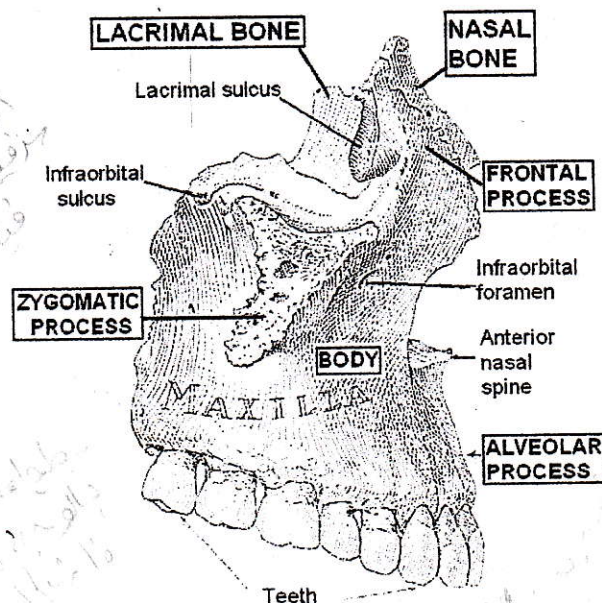
Parts:

- Body, which contains the largest of the pneumatic cavities, the **maxillary sinus**, and presents four surfaces: **facial** (antero-lateral), **infratemporal** (posterior), **orbital** (superior) and **nasal** (medial).
- Four processes arising from the body: **frontal**, **zigomatic**, **palatine** and **alveolar**.

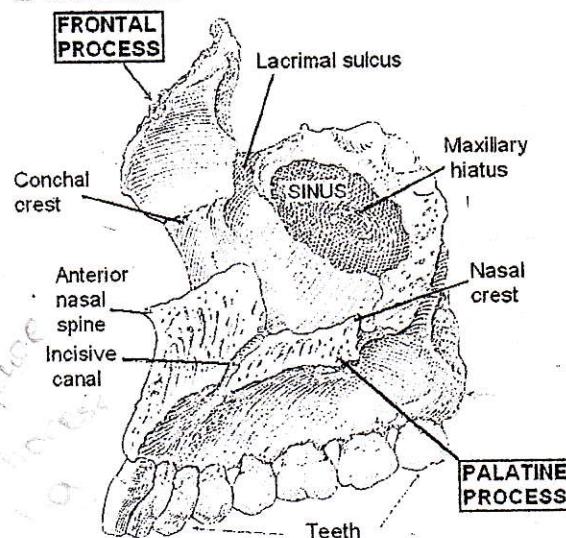
Anatomical details:

- In the anterior surface: the *anterior nasal crest*, the *infra-orbital foramen*, *alveolar eminences* and the small *canine fossa*
- In the posterior surface: the *infra-temporal tuberosity* and many *foramina* for alveolar nerves.
- In the orbital surface: the *infra-orbital sulcus*
- In the nasal surface: the *hiatus* (opening) of the maxillary sinus is the most important and some *crest* to joint to the neighboring bones.

a. LATERAL VIEW



b. MEDIAL VIEW



PALATINE BONE

It is a paired bone and shows a 'L-shaped' bone. It is classified as **irregular bone**.

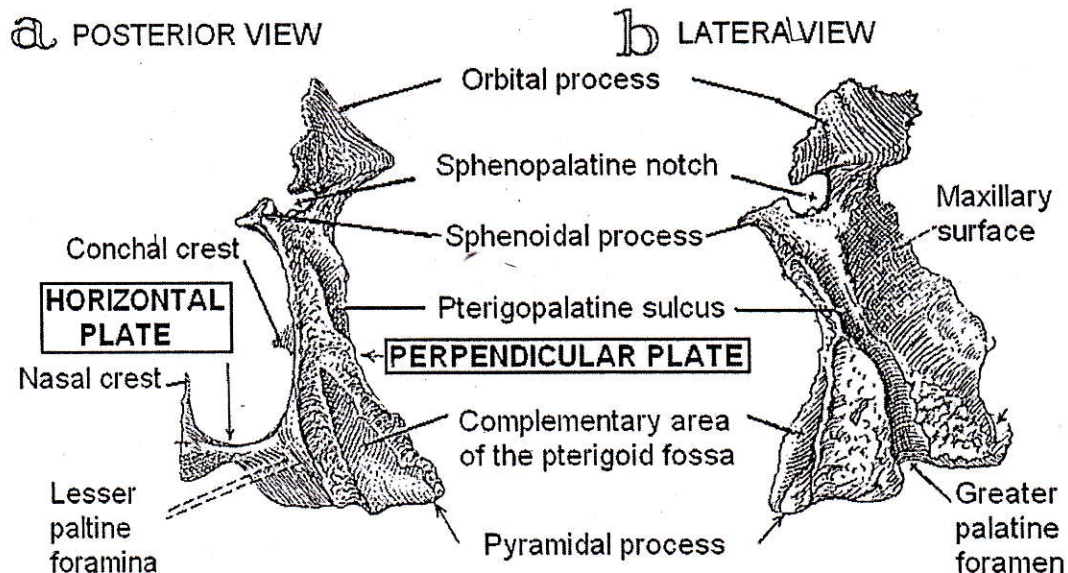
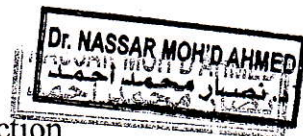
Situation: it is placed behind the maxilla, contributing to form the hard palate and the lateral wall of the nasal cavities.

Parts: taking into account the shape it is distinguished two parts:

- **Perpendicular plate**, at the lateral wall of the nasal cavity, and
- **Horizontal plate**, forming the hard palate together with the palatine processes of the maxillary bones.

Anatomical details:

- The **pyramidal process** arises from the junction between both plates and contributes to complete the pterigoid fossa between both plates of the pterigoid processes of sphenoid bone. It also contains the *major* and *minor foramina*.
- The perpendicular plate splits above into two processes: **orbital** and **sphenoidal**, separated by the **spheno-palatine notch**.
- Seen from the lateral side the *greater (major) palatine sulcus* can be observed.
- The *conchal* and *nasal crests* are observed from medial view.



NASAL BONES (See figures: a, page 14 & page 16)

It is a paired, small, elongated and **flat** piece of compact bone.

Situation: they are at the root or bridge of the nose.

Parts:

We can distinguish **two surfaces** (external and internal) and **four borders**; sutures join most of them:

- To the frontal bone above,
- To the maxillary bone at the sides, and
- To its opposite partner in the midline.
- Its lower border is free to attach to the nasal cartilages.

LACRIMAL BONE (See figures: a, page 14 & page 16)

It is a paired, small, thin, quadrilateral plate of compact bone **located** at the anterior part of the medial wall of the orbit. It is the smallest and thinnest of the skull bones. Together with the frontal process of the maxillary bone, they form the fossa for the lacrimal sac.



INFERIOR NASAL CONCHA (See figures: c, page 7 & a, page 18)

It is a paired, curved plates of bones attached to the inferior part of the lateral wall of the nasal cavity.

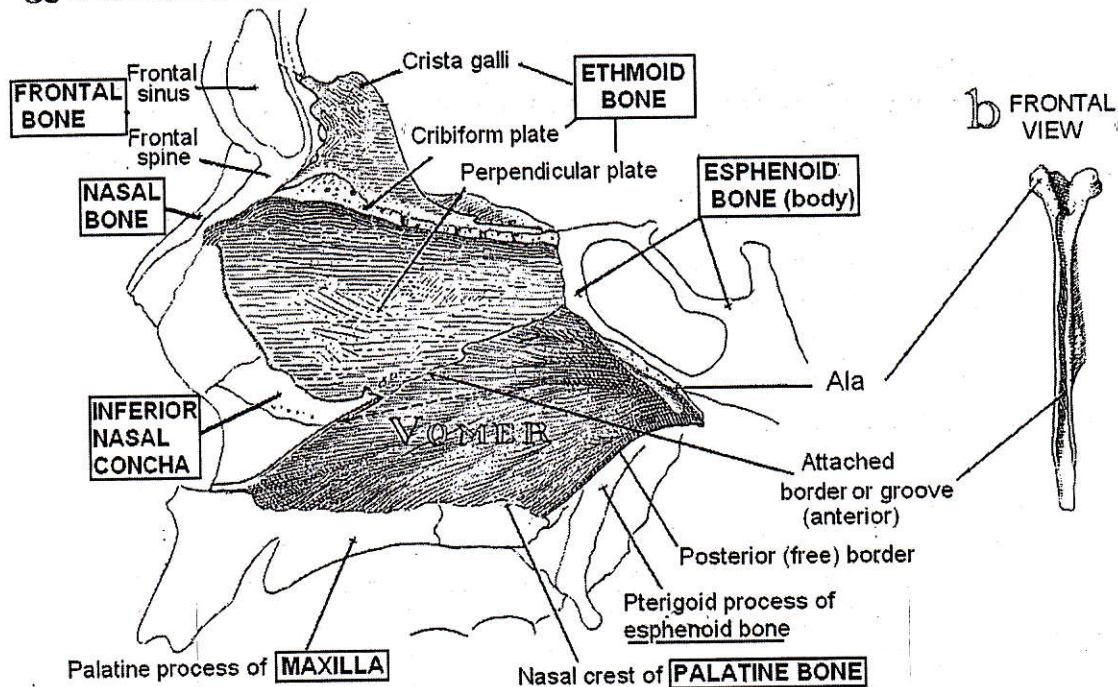
The other two nasal conchae -superior and middle- are structures of the ethmoidal labyrinths that complement and enlarge the lateral wall of the nasal cavity.

VOMER (See picture in the following page: 18)

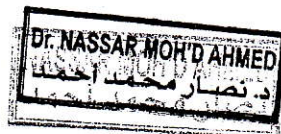
It is an unpaired (single) bone, thin vertical plate of bone forming the postero-inferior portion of the **nasal septum** (situation). Its shape is like ploughshare with a **vertical plate** and a postero-superior **ala**. The free

border (posterior) is the medial boundary of the two posterior nasal openings or **choanae**.

a SAGITTAL SECTION TO SEE THE SITUATION & RELATIONS OF VOMER



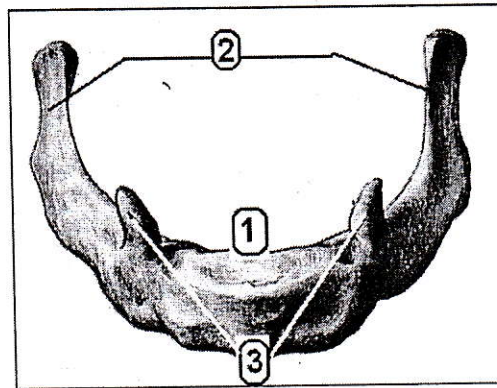
HYOID BONE



It is a single (unpaired) U-shaped piece of bone located at the uppermost part of the neck, between the root of the tongue and the larynx. It consists of three parts:

- Body (1)
- Two greater horns (2)
- Two lesser horns (3)

This bone does not make any joint with any other bone. It is kept in position by the attachments of ligaments and muscles.



Handwritten notes in Arabic script, including a large checkmark and some illegible text.

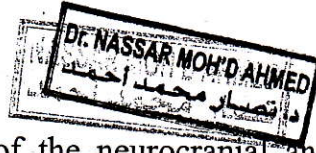
GUIDE FOR PRACTICAL CLASS # 4

Theme: SKELETON OF THE HEAD (SKULL)

Summary: Description of the bones of the skull: classification, anatomical situation, joints, portions or parts and main details or anatomical features .

Objectives:

1. To identify the bones in the skull.
2. To explain the **general characteristics** of the neurocranial and viscerocranial bones.
3. To identify and describe the main **particular characteristics** of these isolated bones.



Methodological orientations (TASKS)

1. In the skull, identify the **neurocranial bones**: occipital, temporal, sphenoid, frontal, ethmoid and parietal.
 - a. At first, precise the skull regions: neurocranium - subdivided into base and calvaria- and viscerocranium.
 - b. To study the general and particular characteristics:
 - It must be revised the general orientation about osteology (logical order), attached to the first guide.
 - It may be helpful to make a summary for this purpose.
 - You need horizontal and sagittal sections of the skull to show well all the bones and to understand the position and the portions of each of them.
 - Besides, you should use the Atlas pictures: figures 57 to 63 and 70 to 113 or the drawings in your summary.
 - c. In order to describe each **isolated bone** the first step should be to place it in the correct anatomical position. To do this it is necessary to orientate the bone taking into account some marks or specific features like:
 - portions,
 - surfaces and borders,

- and some time it is necessary to know some important anatomical details: processes, foramens, etc.

2. Identify the **bones of viscerocranium**: maxilla, palatine, lacrimal, inferior chonca, vomer, zigomatic, nasal, mandible and hyoid.

- Use a complete articulated skull and also a sagittal section of it and an isolated mandible. The first step should be to identify all the bones.
- Use the Atlas' pictures: fig. 94 to 120 or the drawings in your summary.
- Concerning **isolated bones** follow this priority: mandible, maxilla, zigomatic and palatine according the logical order. Localize the other bones and pay attention to their joints. Since it is difficult to get a good hyoid bone separately, it would be better to study it using the fig 112 and 113 of the Atlas.



Bibliography

- Cunningham's textbook of Anatomy. 12th edition. Pages 136 to 150.
- Sobotta/Figge. Atlas of Human Anatomy. Vol 1. Pages 30 to 63.

SOME KEY WORDS (GLOSSARY) TO USE THE DRAWINGS

LATIN	ENGLISH
ala	wing
angulus	angle
arcus	arch
basis	base
canalis (can)	channel, canal
capitulum	head
collum	neck, cervix
condylus	condyle
corpus	body
crista	crest
dente(s)	tooth (teeth)
fascies	surface
foramen	orifice
fovea	small depression

hamulus	hook
hiatus	large opening
incisura	notch, incisure
lamina	plate
linea	line
magna, majus	major, greater
margo	border, margin
os (ossis)	bone(s)
papyracea	orbital
pars	part, portion
parva, minora	minor, lesser
processus (proc)	process
protuberantia	protuberance
pyramidis	pyramid
spina	spine

sulcus	groove
sutura	suture

tuber, eminentia	eminence
tuberculum	tubercle

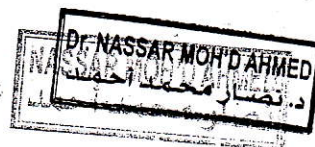
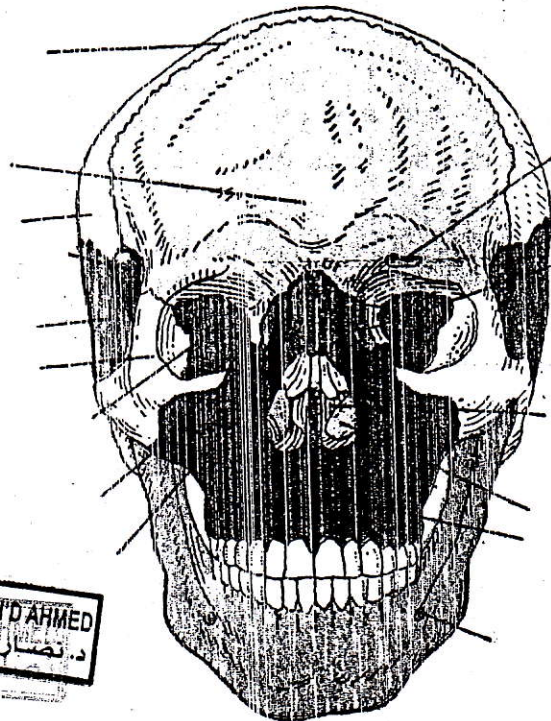
NOTES:

1. Most of the ends '*eus*' in Latin are transformed into '*d*' in English.
Examples: stiloideus → stiloid, pterigodeus → pterigoid, mastoidus → mastoid.
2. The ends '*um*' in Latin are generally translated into English as '*us*' or '*al*'. Examples: meatum → meatus, internum → internal.
3. The ends '*is*' and like in '*jugularis & cerebialis*' **are not** pronounced in English. So they should be considered as the adjectives '*jugular & cerebral*'.
4. In Latin *the noun is before the adjective* while in English is the opposite.

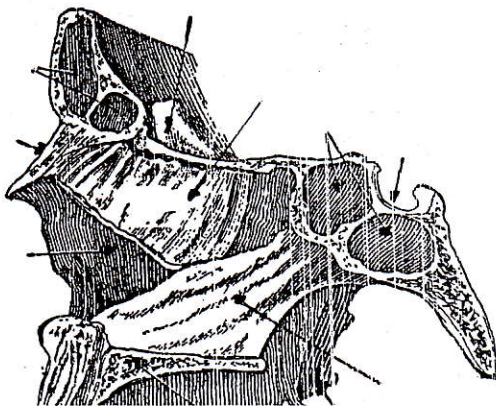


1. Place the proper numbers at the ends of the lines on the diagram.

1. Sphenoid bone
2. Lacrimal bone
3. Mandible
4. Frontal bone
5. Mental foramen
6. Inferior nasal concha
7. Coronal suture
8. Supraorbital foramen
9. Maxilla
10. Zygomatic bone
11. Nasal bone
12. Temporal bone
13. Infraorbital foramen
14. Vomer
15. Parietal bone



2. Write names at the ends of the lines.



3. Four sinuses communicate with each _____